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The English Milling Situation

By D. W. KENT-JONES
Woodlands, Ltd., Dover, England.

In accepting your invitation to send you an article for the Journal of the American Association of Cereal Chemists I felt somewhat uncertain as to what I could write that would be of interest to you in America. Things are so very different in England and America. In America you have a live, active, frank, and essentially successful Association for your flour Chemists, while in England there is no such thing. Many of the large English Mills have Chemists and laboratories but one does not hear of them very much. Outside Mr. Jago, although I have been engaged in the Milling industry for over three years, I cannot remember meeting another cereal chemist, while I have only corresponded with two. Cereal chemists in England are of course not so numerous as in America, but this does not account for the great differences. English millers employing chemists act as secretively as possible. Intercourse with other chemists is not encouraged and we all work independently. We do not know on what lines the others are working or even have anything approaching standard methods of analysis. Since results are scarcely ever compared the necessity for standard methods is not so great. Such a position obviously does not make for progress. Each chemist has in the main to do everything for himself. Personally I have only just finished standardising for my own benefit the ordinary routine analysis tests such as sugars, fats, cellulose, hydrogen ion concentration, etc.

Undoubtedly there is going to be a change for the better soon, and a more or less general and united Research Association for the trade, partly subsided by the Government, is about to come into existence. Thus the many small mills in England will be able to get the advantage of chemical research and the scattered cereal chemists will get more in touch through the medium of the Research Association.

The problems which face the English Miller and his chemist are not always exactly the same problems as you have in the States. As I understand it, there you have your large mills in the big wheat growing district, and hence the mill grist tends to be chiefly of one variety of wheat. In Great Britain and Ireland we have a certain amount of native wheats, but these naturally have to be supplemented by additional supplies of imported wheats. Some idea of the smallness of the wheat production of the United Kingdom may be judged from the fact that although the population is close upon 48 million, native wheats only amount to about 8,000,000 quarters annually. Again whereas (taking the year 1911) United States had 45,500,000 acres under wheat cultivation, Canada, 11,000,000, Argentine and Uruguay 15,000,000, Australia 6,000,000, the United Kingdom only had 1,500,000 acres growing wheat.

To the English millers there come then wheats from United States, Canada, Argentine, Australia, India, Manchuria, Persia, etc. Before the war Russia also sent plentiful supplies. The English miller has then to blend such foreign wheats as are available, so that his flour shall have the necessary strength, color and flavor. Prices asked for the available foreign wheats naturally vary, but the strong wheats of U. S. A. and Canada generally command the top figure. Flour from different parts of

England has however its local characteristics and hence certain districts in England show preference for special varieties of imported wheats. I should like to add in passing, however, that the strength of certain imported wheats such as Australia and India show a marked tendency to increase. In both these countries research in wheat growing has resulted in great improvements in the breed. American, Canadian, and Platte wheats on the other hand show if anything signs of deterioration, and hence it is not unlikely that the superiority of American wheats will be challenged in course of time.

English native wheat is of a very unsatisfactory nature for bread making. Loaves from all English flour are squat, of little volume and poor texture. For bread making there is little demand for all English flour, although large quantities are used for biscuits, pastries and self-raising flour. Even under the best climatic conditions the wheat is poor in strength, although then it is plump, easy to mill, and yields a plentiful, good coloured and well flavored flour.

All English flour, although weak and starchy, has not that dry ricey nature of flour from the weak Pacific Coast wheats. In 1921, the summer in England was exceptionally dry and hot, and the wheat harvested was particularly good for native wheat. In 1922 however, the summer was wet and the wheat even weaker than usual. The sap of the grain remained for a long period in the state of a collateral sol, and only very slowly and incompletely was ripened and coagulated into the dried hydrogel. Such wheat was received into the mill with an average moisture content of 16-18 per cent. The dried gluten on such straight-run flour was about 7.4% and nitrogen 1.25%.

Some idea of the difficulties of the English miller in utilizing such wheat can be imagined.

Now English mills may be roughly divided into two classes;—the port millers and the inland millers. The port millers are usually the large and important firms, and they use little or no English wheats. Imported wheats shipped directly to them and taken into the mill by automatic plants, are as cheap, if not cheaper to them, as the native wheats. The majority of the inland mills however are smaller ones, and it is the presence of cheap native wheats that enable them to compete with the port millers. For them the carriage to the mill on native wheats is small compared to the imported varieties. By suitably blending in various proportions native and foreign wheats, the inland millers are able to produce a flour of sufficient strength to give satisfaction to the baker, and do all a considerable local trade. It must not be forgotten that native wheats are almost invariably several shillings a quarter cheaper than the strong imported ones. Also, that although unsatisfactory in strength, English flour is of exceptionally good flavour and for this reason alone many millers like to have a little native wheats in their mixture.

When it is realized that quite often such very different character wheats as Manitobas, Hard Winter, Durum, Indian, Australian, and English may be blended together, it will be seen that the conditioning of the wheat, so that the mill feed on the rolls is an evenly tempered grain, is of fundamental importance. The subject of tempering and conditioning wheats is possibly of much greater importance to the English miller than to the American. Nowadays the old method of simply adding additional moisture to the wheat and letting it remain thus in a bin for 24-48 hours

is giving way to the modern "hydrolyser." This misnamed hydrolyser receives wheat which has just been wetted by immersion in water and heat it in thin moving streams by radiation in a confined space, so that the external moisture is driven well into the berry. The passage of the wet wheat through the hot conditioner takes a half hour to an hour, and this could perhaps with advantage be extended still further. There would appear to be distinct and definite times of heating, temperatures, and amount of moistures, for each variety of wheat, if the best possible result is to be obtained. The hot conditioned wheat has then to be cooled down and it is ready for grinding. The modern hydrolyser or conditioner is a very valuable plant for increasing the strengths of certain wheats, but it requires attention and some skill or it may even prove to be actually dangerous. It is just as easy, or rather perhaps I should say it is easier to harm wheat as it is to improve it.

England has little or no trade for export flour and all the flour, even the lowest grades, has to be used. Further it must not be forgotten that except in the north of England and Ireland, the home baking trade is small and the vast majority of English people buy shop made baker's bread. The English miller has to compete with a large free of duty importation of foreign flour chiefly from U. S. A., Canada, and Australia. This imported flour, which is often rather low in grade, is strong and cheap. The baker, naturally anxious to buy his flour in the cheapest market, often buys imported flour to add perhaps to some all English flour which again is cheap. The English miller has thus a constant and powerful competitor which ensures the flour he makes being up to scratch. If he suffers certain disadvantages, he can at least plan his wheat blends to give him exactly the strength, flavour, yield, colour etc. that suits his trade. In some parts of England, colour and flavour are of more importance than strength, while in London and the surrounding southern counties there is a demand for a fairly strong baking flour, and cottage loaves are popular. The constant competition of the imported flour trade, the fact that the United Kingdom is at present overmilled, has led to almost suicidal cutting in prices and consequently trade depression. On the other hand it has resulted in the milling industry making every effort to mill scientifically, and, on up-to-date lines. The use of the chemist in the mill, a thing unheard of a few years ago, is now increasing. Greater progress has however been shown recently as in the formation of the Research Association. Further, milling engineering in England has reached high standards.

There is in England at present no demand from the bakers for any guarantee as to the ash or protein content of flours. Severe competition ensures that baking flour is up to scratch. Regularity is however, as in America, a particularly important point and here the value of the cereal chemist is becoming more and more apparent. Again the mill qualities, particularly strength, of different shipments of the same class of wheat, have been found to vary somewhat and the advice, guidance, and judgment of the chemist is here again invaluable. Special quick strength process tests are attracting much attention in England.

Some actual examples of the great variation in strength met with may be of interest. For some months a mill was using Argentine and Plate wheats (30-40 per cent of the total mixture) which were of fairly good and average strength. They were somewhere between Red Winters

and Hard Winters. A fresh consignment of Plate wheat however, had to be blended very differently, as this new shipment, although normal in appearance, was found to have a strength scarcely stronger than the ordinary weak native wheats.

The English native wheats again have many different varieties which vary in strength. The actual varieties are many, but three main classes can be noticed. The white wheats, the red wheats, and Yeoman wheat. White wheat is particularly weak though it yields a fine white flour. Red wheat is only just stronger. Yeoman wheat is a a new variety introduced by Professor Biffin of Cambridge University working in conjunction with the Home Grown Wheat Committee of the National Association of British & Irish Millers. Yeoman wheat, which has been reproduced for several successive seasons and is now grown in considerable quantity, is undoubtedly a big improvement on ordinary English wheat. It yields a much stronger flour (about the strength of Australian and occasionally somewhere approaching the quality of Hard Winter), and keeps its strength remarkably inspite of bad climatic conditions. It yields an excellent crop of wheat, as much as 12 quarters per acre having been obtained, while the average throughout England for this variety must be as high as 6 quarters an acre. This comparatively strong native wheat, a forerunner of possibly even better wheats, for Professor Biffin's work is continuing, has been a great boon to the small English country millers, who of necessity must use a high proportion of native wheats in their blend. In Dover we have been able for months to produce a strong flour, capable of holding its own with the big London port mills, from a wheat blend containing 40 per cent native (Yeoman) wheat. Yeoman wheat is apt to get mixed rather with ordinary English wheat with certain careless farmers and the appearance of the grain is often deceptive. The use of a chemist here is again especially advantageous.

Bleaching of flour and the treatment of flour with improvers is popular and prevalent in England. The Alsop bleacher (No. 2) is probably by far the most used. The legality of bleaching has been fought out in the courts, and it is not likely that the authorities will interfere. The Wesener process (under the name of the flour maturing process,) employing chlorine and nitrosyl chloride is also installed in many mills, although it has not yet reached the popularity it appears to have obtained in America. Nitrogen trinchloride has recently been introduced but as yet very few mills are using it. The same applies to the Novadel Process.

Flour improvers have been used in England for many years. Undoubtedly Ammonium Persulphate, sold under the trade name of Salox, is the most popular. Some idea of the extent of its use may be judged from the fact that Salox is used at the rate of 1 oz. per sack (280 lbs. of flour,) and from the sales it is computed that no less than 12,000,000 sacks of flour out of a total of 30,000,000 annually milled in England are treated with this improver. Calcium acid phosphate under various trade names also enjoys a considerable trade.

I have endeavored to point out in this short article facts which may be of interest in America and to emphasize the points where American and English problems and practice may differ. Such would be very incomplete were not the great difference between English and American bread pointed out. In America your bread is often made rich with lards, milk, sugars, malts etc. In England the vast majority of bread is made

very plainly. High speed doughs, which Mr. Jago informs me are common with you, are unheard of in England. An increasing majority of bread in England is made on the short four hour dough system. Flour, water (approximately 15 gallons per sack of 280 lbs. flour,) yeast (3½ lbs. a sack) and salt (3½ lbs. a sack) are all the ingredients. Occassionally malt extract is used at the rate of 1-lb. a sack, but this is by no means general. Seeing that no sweetening or shortening ingredients are added, it is especially important that the flour itself, should produce a loaf of good flavour. The value of a proportion of native wheats in the blend is here seen. Further, as far as I can judge from my own hydrogen ion concentration experiments on commercial doughs and breads, the dough in England is taken greener than in America. That is to say while American commercial bread has generally a *P*. H. value of 5.0-5.7, English commercial bread is seldom below *P*. H. 5.5. It is quite often 5.8, 5.9 etc. Bread with a much higher hydrogen ion concentration would tend to be rather acid for English liking.

Generally speaking however there would not appear to be very much difference between English and American flour judged from the analytical results published in your journal. Possibly the ashes of English flours are on the whole somewhat lower than American flours, while the English flours again appear to be less buffered than your own.

Before closing I should like to congratulate the American cereal chemists on their valuable journal and to say that I have found it extremely useful. I believe your Association, of which I am very proud of being a member, makes more than anything I know for progress in the mill. I must own that I look forward very eagerly to each number, and I have never yet failed to learn something useful from each and every publication.

Recent Durum Wheat Investigations at the North Dakota Experiment Station

By C. E. MANGELS
North Dakota Agricultural Experiment Station

Durum wheat was introduced into this country about twenty-five years ago. The durum types of wheat are distinctly different, not only botanically but also in other characteristics, from the vulgare or common wheat. Durum wheat is also produced in Russia, Italy, and Northern Africa and also to a limited extent in Canada. Durum wheat production in the United States is practically confined to the four states, Minnesota, North Dakota, South Dakota and Montana. The state of North Dakota produces more than half of the total produced in the United States. The Department of Agriculture gives the durum wheat production in 1921 as 49,553,000 bushels, and of this total 33,336,000 bushels was produced in North Dakota. The durum wheat production has shown considerable fluctuation from year to year, but there has been a general tendency to increase the production.

The durum type of wheat, it is now agreed, is primarily suitable for the production of macaroni and similar products. It is strange, therefore, that until very recently little or no investigational work has

been done regarding the utilization of durum wheat for macaroni and similar products. It has been often assumed, unfortunately, that any durum wheat would make suitable macaroni. The South Dakota Station did conduct investigations some 20 years ago on the use of durum for macaroni. The general purpose of these investigations was evidently to show that American grown durum was just as suitable for macaroni, as that produced in foreign countries.

While investigations have neglected the utilization of durum wheat for macaroni, we find considerable investigational work on the use of durum wheat flour for bread. Durum wheat is used for bread in Europe, particularly in Russia, but has never met with favor in this country. These European countries evidently do not object to a heavy bread, but the American public prefers a lighter bread. Durum wheats apparently cannot compete with our hard common wheats as a bread wheat, and as long as we have high quality common wheat available, the durum wheat will probably not be popular as a bread wheat—unless we can greatly change or improve it's bread making quality. It is not the purpose of this paper to discuss bread making qualities of durum wheat, but to give the results of investigations on the utilization of durum for macaroni and similar products.

The macaroni industry in the United States was comparatively insignificant before durum wheat was introduced into the Northwest. The macaroni products consumed were practically all imported. The macaroni industry and the semolina milling industry became well established after a suitable supply of raw material was available. The prosperity of the American macaroni industry, therefore, depends to some extent upon a suitable supply of raw material. In the investigations undertaken at the North Dakota Station we have endeavored to give first attention to important commercial problems dealing with raw material. The quality of raw material (or grain) in macaroni production is very important, since usually only water is added in the process of manufacture, and the quality of raw material directly effects the quality of the finished product. The trade apparently demands a macaroni product which at least has the two following qualities:

(1) The product will be soft cream to creamy yellow in color.

(2) When cooked the product will not disintegrate but will keep it's shape.

The investigations conducted so far have dealt principally with the influence of variety on color.

Experimental

Relation of variety to color—These are two general types of durum wheat produced in the United States—amber durum and red durum. The trade has discriminated against the common red durum or D-5 for some time on account of lack of creamy color, but until recently it was assumed, that all amber durum varieties were satisfactory for macaroni. The varieties originally introduced were probably satisfactory, and the two principal commercial varieties—Arnautka and Kubanka are evidently satisfactory. New varieties have been introduced, however, from time to time, and these varieties were selected on account of high yielding power or rust resistance, without reference to their technical value. The most important varieties commercially are Arnauthka, Kubanka, Monad,

Acme and D-5. Varieties of lesser importance are Mindum, Peliss, Kahla and Buford.

In order to determine the color tendencies of the different varieties we have examined, flour, bread and macaroni, made from different samples of each variety. The observations on color of flour and bread was made on a number of samples from different parts of North Dakota, while the observations of all three products was made on a limited number of samples. Observations have been made on the 1921 and 1922 crops.

Color of Flour

The color shade of the flour is most easily determined by the "pekar" or "slick" test. Table I (1922 crop) gives the results of observations on the flour of different varieties from six different locations. It will be noted that the predominating color of Arnautka and Kubanka varieties is creamy to light yellow. The Monad samples show some tendency to be creamy, but the predominating color is not satisfactory. Monad shows considerable variation in color. The Acme and D-5 are not satisfactory, showing reddish or brownish tints, as does the Monad in some cases. The sample of Monad from Williston in the northwest part of the state, is designated as "whittish gray "and shows entire absence of creamy or yellow pigment. The peliss and Mindum varieties show good color, particularly the Mindum. The Kahla variety is variable, but the sample from Edgeley southeastern North Dakota) has a satisfactory color. There is some indication of variation due to climate, but it will be noted that the Kubanka and Arnautka varieties tend to give a fairly good color in all cases.

Color of Bread

Baking tests have been made on durum wheats grown at Fargo and the five sub-stations (Dickinson, Edgely, Langdon, Williston and Hettinger.) The color shade of the bread was observed for the 1921 and 1922 crops. Tables II and III show the color shade of bread for the 1921 and 1922 crops respectively. The difference between Kubanka and Arnautka and Monad, Acme and D-5 are accentuated as compared to the color of flour.

It will also be noted that so far as Arnauthka, Kubanka, Monad, Acme and D-5 are concerned, the results on the 1921 crop are similar to the 1922 crop. The Kahla variety is an exception, since all samples of this variety show a creamy color in 1921, while this variety was not so satisfactory in 1922. The fact that the color differences persist after fermentation and baking indicate that the color difference is due to inherent differences in the composition of the wheat, and is not due to the physical condition of the semolina. Some varieties, therefore, evidently carry the desirable yellow pigment while others do not. Climatic differences may, and very probably do have some effect, but some varieties evidently persistently carry more yellow pigment than others.

Color of Macaroni

For this experiment a limited number of 15 bushel samples were used. In all nineteen large samples were secured, representing different varieties. The lots secured were from the 1921 crop, and a small sample of each lot was planted in the spring of 1922, in order to ascertain definitely that the lot was of the variety represented. As a result of these

field tests the results from three lots of wheat were discarded due to uncertainty of variety. The lots tested represented 4 samples Monad, 3 samples each Kubanka and D-5, 2 samples Acme and one sample each Arnautka, Mindum, Buford, and Red Durum N. D. 46.

The fifteen bushel lots were milled to semolina in the Experiment Station Mill, and 300 pounds of semolina sent to the Creamette Co., of Minneapolis for conversion into macaroni products. The Creamette Co., converted the semolina into macaroni products and these products were returned to the laboratory for examination. A portion of the semolina was also reduced to flour. The color shape of this flour was noted, and the color of bread baked from this flour was also observed. Table IV shows the results of observations on flour, bread, and macaroni. The data on color from this lot of samples is not as clear cut as in case of small samples from the sub-stations. The milling equipment available was not well adapted to semolina milling, and we were unable to obtain a clean semolina, free from bran particles. While all samples were handled, as much as possible in the same manner, the lots of semolina were not uniform. Some lots contained more bran particles than others, and this may have obscured results in some cases.

The sample of Arnautka gave a cream colored macaroni, but it was too light. The best samples of macaroni were from the Buford and Mindum samples, but the Kubanka from Dickinson (western North Kakota) was almost as good. Out of three samples of Kubanka, two gave a satisfactory macaroni. The Kubanka from Casselton (a few miles west of Fargo,) however, gave a very poor colored macaroni. The macaroni from the Fargo Monad sample was of very good color, but three other samples were poor. The two Acme samples were both decidedly poor. The three samples of D-5 were all unsatisfactory. The sample from Eldridge (near Jamestown) was very dark, but this very poor color may have been partly due to included bran particles. The N. D. 46 is a variety of Red Durum, the grain of which is similar in appearance to D-5, but the flour from N. D. 46 has an intense yellow color. The macaroni from this variety, however, has a slight brownish cast. In this case the color is probably too intense.

It will be noted that there is a distinct correlation between color of macaroni, bread, and flour. The color of flour, in the writer's opinion, follows the color of macaroni much more closely than the color of bread. This is to be expected. The color of the flour, or semolina, particularly after wetting and drying would appear to be a very satisfactory index of the color of the resulting macaroni.

The Monad variety shows considerable variation in color. It has been suggested that the poor color in Monad might be due to the wheat scab disease, since Monad is particularly susceptible to this disease. The years 1921 and 1922, however, were not scab years. The Kubanka, Arnautka and Mindum varieties apparently show satisfactory color quite consistently. Monad is variable in color and of doubtful value, while Acme and D-5 are unsatisfactory. Buford and Peliss are not important commercially, but appear to have satisfactory color.

Cooking Quality of Macaroni

Good macaroni should not disintegrate when cooked, but should retain it's characteristic shape. The sixteen samples of macaroni were sub-

mitted to another laboratory for a cooking test. Table V shows the results of cooking tests and the protein content of the semolina used for the macaroni. It will be noted that the consistency of all Kubanka samples, and the Arnautka and Mindum samples is called "very good." One sample of D-5 is also called "very good." The Buford sample was called "too starchy." Three out of four samples of Monad are called "too starchy." One sample of Acme is "starchy." One sample each of Acme and Monad with very high protein content are characterized as "tough, elastic, good." The cooking tests were secured through the co-operation of the Office of Home Economics, U. S. Department of Agriculture, Washington, D. C.

The cooking tests indicate that Arnautka, Mindum and Kubanka are probably satisfactory, while other varieties are doubtful. "D-5" appears to be better than Monad. We cannot ascribe the difference in cooking quality entirely to difference in protein content. Within a variety the difference in protein content would appear to influence the consistency, with some exceptions, but between varieties the protein content cannot be the sole factor. The data in Table V suggests that the cooking qualities of macaroni products are influenced by constituents other than protein content. While the character of the protein may influence the cooking qualities, the writer is of the opinion that we are more likely to find causes of difference in the carbohydrates of the semolina. Macaroni from durum semolina is translucent and when broken shows a glassy fracture. A dried paste of common wheat is opaque. The cause of difference in cooking qualities is a subject which needs further investigation.

Summary

The Kubanka and Arnautka varieties are now the principal commercial varieties in North Dakota and they are satisfactory for macaroni. The Arnautka is being displaced by Kubanka and other varieties of higher yielding power. The higher yielding power is probably due principally to better resistence to stem rust. The Monad, Acme and D-5 varieties are very resistent to stem rust and are high yielders. At Fargo where rust was a large factor the increase in yield is quite marked. The yield at Fargo were Kubanka 24.2, Arnautka 18.8, Monad 41.8, Acme 36.8 andD-5 36.6. Monad and D-5 also show relatively high yields at Edgely as compared to Kubanka and Arnautka. At Edgely the yields were Kubanka 20.8, Arnautka 19.5, Monad 27.5, D-5 25.8. On account of high yielding ability these varieties have met with favor, but their low technical value makes their continued production inadvisable. Our need at present is for high yielding and rust resistant varieties which also carry high technical value for macaroni manufacture. Such varieties are now in course of development at the North Dakota Experiment Station. The development of such varieties will insure a supply of proper raw material to the semolina miller and the macaroni manufacturer.

Acknowledgement

The writer wishes to express appreciation for the cooperation of the Creameet Co., of Minneapolis, and Dr. M. C. Denton, Office of Home Economics, U. S. Department of Agriculture and suggestions from Dr. P. F. Trowbridge, Director of the North Dakota Experiment Station.

Table I.
Color Shade of Straight Flour
1922 Crop—Pekar Test.

	ARNAUTKA	KUBANKA	MONAD	ACME	D-5	PELISS	KAHLA	MEDIUM
Fargo	Med. Yellow S. Gray	Deep Creamy S. Gray	Dk. Yellow-ish Gray	Dk. Yellowish Gray	Reddish Gray	Deep Creamy Yellow	Dark Gray	V. L. Cream Clear
Langdon	Clear Creamy	Dk. Yellow S. Gray	Creamy Gray		Brownish Gray			
Edgely	Light Cream V. S. Gray	Deep Creamy Yellow	L. Brownish Gray	Dk. Brownish Gray	Med. Brownish Gray	L. Cream	L. Creamy Yellow	
Williston	Creamy	Creamy	Whitish Gray	Creamy Gray	Dk. Reddish Gray	Dk. Yellow S. Gray	Whittish Gray	
Dickinson	P. Yellow	L. Yellow	Med. Yellow S. Gray	Deep Gray Yellow	Reddish Gray			
Hettinger		L. Creamy Yellow	L. Reddish Gray					

Table II.
Color Shade of Bread Flour, Durum 1921 Crop

STATION	VARIETY						
	ARN0UTKA	KUBANKA	MONAD	ACME	D-5	PELISS	KUHLA
Fargo	Creamy Gray	Creamy	Creamy Gray	Gray	Creamy Gray	Creamy	Creamy
Langdon	Creamy	Creamy	Creamy Gray		Gray		
Edgely	Creamy	Creamy	Gray	Gray	Gray	Creamy	Creamy
Williston	Creamy	Creamy	Gray	Gray	Gray		Creamy Gray
Dickinson		Creamy	Creamy Gray				

Table III.
Color Shade of Bread from Durum 1922 Crop

STATION	VARIETY							
	ARNAUTKA	KUBANKA	MONAD	ACME	D-5	PELISS	KAKLA	MINDUM
Fargo	L. Yellow	L. Yellow	Gray White	Gray White	Gray	Creamy	Very Gray	L. Yellow
Langdon	Creamy	Creamy Yellow	Gray		Creamy Gray			
Edgely	L. Yellow	L. Yellow	Gray	Creamy Gray	Gray	Creamy Yellow	Yellow	
Williston	Creamy Yellow	Creamy Yellow	White	White	Gray	Creamy Gray		
Dickinson	Creamy	L. Yellow	Gray White	Gray White	Gray		Gray	
Hettinger		L. Yellow						

Table IV.
Flour Bread and Macaroni from Large Samples 1921 Crop

Variety	Location	Color of Flour	Color of Bread from Semolina	Color of Macaroni
Arnautka	Dwight	Creamy S. Gray	L. Creamy V. S. Gray	Whittish Cream
Kubanka	Dickinson	Deep Creamy Yellow	Very Creamy	Deep Creamy Yellow
Kubanka	Langdon	Med. Cream V. S. Gray	Creamy Gray	Slightly Grayish Cream
Kubanka	Cassleton	Deep Cream, S. Gray	Creamy, sl. Gray	Gray Brown
Monad	Fargo	Creamy S. Gray	L. Cream sl. Gray	Grayish Cream
Monad	Dickinson	Dk. Brownish Gray	Grayish Cream	Brown
Monad	Afred	Dk. rownish Gray	Very Gray	Brownish Gray
Monad	Windsor	Creamy Gray	Gray sl. Creamy	Brownish Gray
Acme	Ypsilanti	Whittish Gray	Gray	L. Brownish Gray
Acme	Highmore, S. D.	Very Gray	Gray	Dark Grayish Brown
D-5	Tower City	Whittish Gray	Gray, sl. Creamy	Brownish Gray
D-5	Wilton	Gray, sl. Brownish	Gray, sl. Creamy	Whittish Brown
D-5	Eldridge	Brownish Gray	Grayish Cream	Dark, Brownish Gray
Mindum	Crookston	Light Cream	L. Cream	Light Cream
Buford	Williston	Very Light Cream	Very Creamy Light	Light Cream
N. D. 46	Courtenay	Yellow, S. Gray	Yellow	Brownish Cream

Table V.
Cooking Qualities and Protein Content

Variety	Location	Crude Protein %	Consistency of Cooked Products.
Arnautka	Dwight	12.62	Very good.
Kubanka	Dickinson	17.81	Very good.
Kubanka	Langdon	12.74	Very good.
Kubanka	Casselton	13.00	Very good.
Monad	Fargo	13-46	Slightly starchy, good.
Monad	Dickinson	17.52	Tough, elastic, good.
Monad	Alfred	14.54	Very starchy.
Monad	Windsor	12.81	Too starchy.
Acme	Ypsilanti	12.69	Slightly starchy, good.
Acme	Highmore	16.08	Tough, elastic, good.
D-5	Tower City	13.30	Very good.
D-5	Wilton	12.48	Slightly starchy, good.
D-5	Eldridge	12.88	Slightly starchy, good.
Mindum	Crookston	13.22	Very good.
Buford	Williston	11.06	Too starchy.
N. D. 46	Courtenay	12.24	Tough, elastic, good.

Has Northwestern Spring Wheat Deteriorated?

By CHAS. H. BRIGGS
The Howard Wheat and Flour Testing Laboratory.

Has the quality of Northwestern Spring Wheat deteriorated? Innumerable times this question has been asked of the Howard Laboratory. There has for a long time existed a rather wide-spread idea that this type of wheat is not as good as it was 5, 10 or 15 years ago. Is this just an example of placing the Golden Age of wheat quality in the past or has there been a degeneration of the varieties of wheat, a depletion of soil or a distinct change of climate? The partial substitution of the so-called Velvet Chaff variety in some localities for the former standard Blue Stem and Fife varieties and, beginning in 1912, the growing popularity of Marquis have served to keep this question in the foreground. Contrary to the general impression, there is no evidence from records of the Weather Bureau to show that th climate of the Northwestern States has changed, hence if a period of years be averaged, the weather will have to be ruled out as an effective cause of deterioration. It may be possible that soil depletion would bring about deterioration of wheat quality, if wheat were cropped without rotation on the same ground for many years, but leaving aside the new Canadian fields, there is much new ground seeded to wheat each year in the Northwest and in the longer cultivated sections, wheat finds a place in most well-ordered rotation systems, hence this factor nay not be as important after consideration, as it would at first appear.

How far the now very general cultivation of Marquis wheat may influence the trend of quality, is an important one. The value of this variety was early recognzied. Too much emphasis cannot be laid on the importance of selecting for any section, the variety which possesses in the highest degree, those properties which make it of of milling and baking value. The tendency in the past has been

far too generally to select the varieties which showed the largest yield per acre, disregarding the character of the wheat as measured by its flour yielding ability and the quality of that flour. Marquis is a notable exception to this procedure, yet it is by far no means all that could be sired from the milling standpoint. It appears to be possessed of a thicker branny coat on the average than the older varieties and therefore to give a lower flour yield. There is an opportunity for an improved variety that shall possess in larger measure all the properties valued by the farmer, the miller and the baker. The farmer's interest ought not to overshadow the interests of the miller in having wheats of high flouring value. But millers and grain buyers themselves have not always been as far-sighted in offering premiums for such wheats as, for the advantage of both farmer and buyer, would have been the wise policy.

But without further discussion of the separate questions involved in the question which forms the title of this paper, I shall present the figures which will, I believe, answer it. The figures which follow have been compiled from the results of many thousands of tests of the wheats of the past 16 years. In first collecting the figures which were to enter into the averages, all tests of durums and both hard and soft winters were of course omitted and likewise Canadian wheats. We chose to use the amounts of dry crude gluten rather than of crude protein as the measure of the quality of spring wheat, both because millers and grain men have in greater proportion required the gluten test and because, for reasons which were set forth quite fully in an aticle published in the Northwestern Miller of Sept. 20, 1922, by the author of this, the gluten test gives results which more accurately express the quality of wheats and flours for breadmaking.

On the basis of this compilation of averages of results of numerous gluten tests made by us, it can fairly be asserted that, taking consideration of the expected annual fluctuations of quality, the average quality of Northwestern spring wheat has not noticeably deteriorated in the past 16 years. The average results are as follows:

Crop of	Per Cent.	Crop of	Per Cent.
1907,	11.70	1917,	12.99
1908,	11.50	1918,	12.18
1909,	12.64	1919,	11.51
1910,	12.42	1920,	12.35
1911,	13.80	1921,	12.37
1912,	11.67	1922,	12.02
1913,	11.56	Average,	12.03
1914,	11.29	Lowest,	7.8
1915,	10.93	Highest,	19.6
1916,	11.51		

Attention is invited to the high figures of 1911 and 1917 and the low figures of 1914 and 1915; also to the practical identity of the figures for the crops of 1908, 1913, 1916 and 1919. It would be interesting to attempt to correlate weather conditions in these years with the results here presented but the writer has not found opportunity and, at any rate, feels with Mark Twain, that nothing much can be done about it. The practical thing is, as suggested above, the development of wheat varieties combining in perfect balance (1) high yielding ability under

the severe handicaps of Northwestern conditions, (2) high milling yield of flour, having (3) glutenous, bright colored, sound and highly water-absorptive quality. The writer would rather have the honor of developing such a wheat than to be president. It is his hope to have the opportunity to recognize and acclaim it when it shall be developed. The other practical thing is to do all possible to aid the farmers to follow the best cultural methods so that the superior quality of spring wheat may in years to come be not merely maintained but advanced.

An Examination of Some Self-Rising Flours

By L. H. BAILEY
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The self-rising flour industry has been developed in the United States largely within the last ten years. Self-rising flour was first manufactured in Nashville, Tennessee, but now it is produced in most of the sections of the country where soft wheat flour is available. The annual output is estimated to be about ten million barrels. While self-rising flour is produced in different parts of the country, most of it is sold in the states east of the Mississippi River and south of the Ohio River. In fact, it is said that in some of these states as much as ninety per cent of the flour used is self-rising.

In order that the Bureau of Chemistry might be better informed about this new food industry, the writer was sent into the field to gather information on the subject. Mills and blending plants in ten of the southeastern states were visited and the process of manufacture was observed.

A large part of the self-rising flour produced is made by mixing monocalcium phosphate, bicarbonate of soda, and sodium chloride in definite proportions with soft wheat flour. The proportions used differ somewhat at the various plants. In a few cases another acid constituent is substituted for the monocalcium phosphate, either in whole or in part. Sodium acid phosphate and potassium acid tartrate have been used for this purpose.

Weighed quantities of flour, leavening agents, and salt are placed in a flour mixer and blended by agitation. When blended this portion is removed and a new charge is added. So far as the writer is informed this intermittent process of mixing is the one ordinarily used.

As dampness must be avoided in the case of self-rising flour, manufacturers carefully select the salt that they use. Salt that becomes damp and lumpy is not suitable for this purpose. If self-rising flour becomes damp, small aggregations, called "pit balls," form in the flour which then loses some of its leavening power and is unsalable. Manufacturers and dealers alike try to avoid this condition. Merchants buy relatively small quantities of self-rising flour at one time in order that they may always have a product that will be in good condition when sold. The writer was informed that, in general, self-rising flour is used within three months after it has been manufactured.

Self-rising flour is used almost exclusively by the household trade.

It is packed, usually in six, twelve and twenty-four pound sacks, seldom in sacks of other sizes, or in cartons. It is sold for the most part in the original packages; occasionally a dealer sells from bulk.

The grade of flour used in making self-rising flour is governed by the demands of the trade. In certain places only high grade flour is sold, while in others lower grades are more popular. In some sections money is so scarce that the cheapest flour that can be bought is the one in greatest use. Some of the larger mills make several grades of flour to meet the particular demand of different sections, and again a number of mills put out the same goods of flour under different brands. The prices vary with the grades.

Visits were also made to flour brokers, wholesale flour merchants and retail grocery stores. Samples, large and small, were collected from all of these sources—in all about ninety different samples were obtained. These were manufactured in sixteen states. Those procured from the mills and blending plants were strictly fresh goods, while those secured from the merchants were of indefinite age. It is known that some were at least several weeks old, for they had been manufactured in the Far Northwest, and shipped down the Pacific Coast, through the Panama Canal, and up the Atlantic Coast to a port in one of the South-Eastern States. An effort was made to collect the oldest samples that could be found in the regular channels of commerce as well as the newest.

These samples were sent to the Bureau of Chemistry for examination. A miscroscopical test (U. S. Department of Agriculture Bulletin 1130, "Significance of Wheat Hairs in the Microscopical Examination for Flour," by George L. Keenan) of the flours was made to determine the grade or class of flour that had been used in their manufacture. The flours were classified on the basis of hair count. Those having a low hair count were designated as first class flour, those with a medium hair count as second class, and those with a high count as third class. There is not a sharp line of demarcation between these classes, but in this work a count of approximately twenty wheat hair was arbitrarily chosen as the dividing line between the first and second calsses of flours and seventy as the line between second and third classes.

The real test of flour is the character of the baked product that it is capable of producing. All these flours were baked into biscuits as soon as convenient after they had been received at the laboratory.

Personal Formula.

Self-rising flour	227 grams
Shortening	15 grams.
Water	as required.

The shortening was thoroughly mixed with the flour, and enough cold water to make a soft dough was added. The dough was put inside an embroidery hoop placed on the table top and rolled to the thickness of the hoop. Seven biscuits were cut with a cake or biscuit-cutter, and the excess dough was descarded. The seven biscuits, all being of the same diameter and thickness, were put in a baking dish and baked at a temperature of about 240° C. for a period of 12 to 15 minutes. After baking, the biscuits were cooed, weighed, and measured for volume in groups

of seven. The seven biscuits taken together constituted the test bake for each sample. The volumes of the biscuits were obtained by the replacement of equal volumes of rape seed. The groups of biscuits were then photographed, after which they were broken open and scored for appearance and color of crust and appearance and color of crumb. The results of this examination are shown in the attached table.

The volume of a biscuit depends upon the character of the flour, the condition of storage, the proportion of leavening agents added, the method of handling, etc. An effort was made to handle all of these flours alike. The average volume of seven biscuits was 559 cc.; the maximum volume was 640 cc., and the minimum volume was 460 cc. The weight of a biscuit also depends upon the character of the flour, the quantity and quality of leavening agents and the quantity of water that is retained in the baked product. The average weight of seven biscuits was 217 grams. The maximum weight was 244 grams and the minimum weight was 186 grams. Biscuits made from some flours do not have even and smooth crusts, but have irregular surfaces. When these self-rising flours were scored for appearance of crust, 9 were graded as poor, 36 as fair, 45 as good, and 2 as very good.

The color of the crust varies somewhat with different flours, even though the biscuits are baked at the same temperature. Those having a light brown color were graded the highest. On the basis of the color of the crusts, 4 groups were graded as poor, 23 as fair, 60 as good, and 5 as very good.

Under appearance of crumb were considered the lightness or flakiness of the crumb and also its texture. Of these biscuits one group, which had a bitter taste, was scored as bad, 6 were too firm, 5 were coarse, 9 were poor, 28 fair, 39 good, and 5 very good. Several factors contribute toward producing the color of the crumb. A low grade flour produces a grey color, and an excess of soda a yellow color. An excess of soda and an excess of moisture with a low grade of flour make a dark colored biscuit. A high grade soft wheat flour will make a white biscuit and a bleached flour will make a very white one. An unbleached flour of certain wheats will give a cream colored biscuit. According to color, 8 groups of these biscuits were scored as yellow, 2 as gray, 13 as dark, 4 as very dark, 31 as white, 11 as very white, and 23 as cream.

In the general score of these biscuits 2 were graded excellent, 7 very good, 38 good, 37 fair, and 8 poor.

The conclusion drawn from the examination of these 92 samples of self-rising flour, taken from the ordinary channels of commerce, is that a large proportion of them were capable of producing biscuits that had good color and appearance. They were well leavened and palatable. Some, however, were inferior in texture, volume, general appearance, and color. The characteristic yellow color of many of the biscuits was undoubtedly due to an excess of soda. A grey or dark color resulted from the use of the lower grades of flour. The inferior biscuits also had poor texture and small volume.

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SELF-RISING FLOUR BISCUITS
(Seven Biscuits are Considered Together as a Unit.)

Nos. F. C.	Photo Nos.	BISCUITS Vol. c c.	Wt. gms.	Spc. Vol. or cc. per 100 gms.	CRUMB Appearance	CRUMB Color	CRUST Appearance	CRUST Color	General Score of Biscuits	FLOUR Wheat Hairs in 5 mg.	FLOUR Class No.
5739	1	570	200	285	Good	Good	Good	Cream	Good	44	2nd
5749	2	580	196	296	Good	Good	Good	Cream	Fair	48	2nd
5750	3	540	191	283	Good	Good	Good	White	Good	86	3rd
5751	4	540	189	286	Fair	Good	Fair	Dark	Fair	63	2nd
5752	5	580	192	302	Good	Good	Very good	White	Good	31	2nd
5753	6	600	190	316	Good	Good	Coarse	White	Good	49	2nd
5754	7	540	186	290	Fair	Fair	Good	White	Fair	43	2nd
5755	8	600	218	275	Fair	Good	Fair	Yellow	Fair	77	3rd
5756	9	640	222	288	Fair	Good	Fair	Yellow & Dark	Good	59	2nd
5757	10	580	218	266	Fair	Good	Good	White	Fair	57	2nd
5758	11	600	208	288	Fair	Good	Good	White	Good	43	2nd
5759	12	520	214	243	Fair	Good	Good	Very White	Fair	9	1st
5760	13	600	186	323	Good	Good	Coarse	Cream	Good	73	3rd
5761	14	480	204	235	Good	Fair	Too firm	Dark	Fair	93	3rd
5762	15	520	189	275	Good	Good	Good	Very white * *	Good	32	2nd
5763	16	580	190	305	Good	Good (spk.)	Good	Very White	Good	17	1st
5764	17	560	215	260	Good	Good (spk.)	Good	Cream	Fair	48	2nd
5765	18	560	211	265	Good	Good	Fair	White	Very good	17	1st
5785	No Biscuits									36	2nd
5802	19	500	204	245	Poor (spk.)	Poor	Coarse	Cream Yellow	Poor	29	2nd
5803	20	540	194	278	Fair	Good	Fair	Yellow * *	Fair	67	2nd
5804	21	560	205	273	Fair	Good	Good	White	Good	73	3rd
5805	22	540	224	241	Fair	Fair	Good	Very White	Fair	31	2nd
5806	23	560	216	259	Fair	Fair	Good	White	Fair	25	2nd
5807	24	580	241	241	Good	Fair	Fair	White	Good	52	2nd
5808	25	540	218	248	Good	Good	Good	Very White	Fair	20	1st
5809	26	600	209	287	Good	Good	Good	White	Good	20	1st
5810	27	570	220	259	Good	Good	Good	White	Fair	18	1st
5811	28	560	229	244	Good	Fair	Fair	Grey	Fair	86	3rd
5812	29	460	235	195	Fair	Fair	Too firm	Grey	Poor	47	2nd
5813	30	560	238	235	Good	Fair	Bitter—bad	Bad yellow * *	Poor	33	2nd
5814	31	580	244	238	Good	Good	Firm	Dark	Fair	73	3rd
5815	32	540	229	236	Good	Good	Good	White	Good	39	2nd
5816	33	580	233	249	Good	Good	Good	White	Very good	21	1st
5817	34	600	234	256	Good	Good	Fair	Cream	Fair	17	1st
5818	35	480	243	198	Fair	Fair	Too firm	Dark	Poor	21	1st
5819	36	600	230	261	Good	Good	Good	Cream	Good	28	2nd
5820	37	580	232	250	Good	Good	Good	Cream	Very good	48	2nd
5821	38	560	222	252	Good	Good	Fair	Cream	Fair	31	2nd
5822	39	520	236	220	Good	Fair	Poor	Dark	Fair	31	2nd
5823	40	560	214	262	Good	Good	Good	White	Very good	43	2nd
5824	41	620	228	272	Good	Good	Good	Very White	Excellent	27	2nd

5825	42	580	230	252	Good	Good	Good	Cream	Good	39	2nd
5826	43	540	222	243	Fair	Good	Fair	Cream	Good	45	2nd
5831	44	600	232	259	Good	Very good	Good	Cream	Very good	43	2nd
5832	45	560	228	246	Fair	Good	Good	White	Fair †	28	2nd
5833	46	500	216	231	Poor	Fair	Too firm	Cream	Poor	34	2nd
5834	47	520	234	222	Poor	Poor	Too firm	Cream	Poor	24	2nd
5835	48	560	218	257	Fair	Fair	Fair	Yellow **	Fair	52	2nd
5836	49	560	233	240	Fair	Good	Fair	White	Fair	44	2nd
5837	50	560	219	256	Good	Very good	Good	White	Good	41	2nd
5838	51	580	227	256	Fair	Fair	Good	White	Good	27	2nd
5839	52	560	229	245	Fair	Good	Coarse	Cream	Good	31	2nd
5840	53	560	242	231	Poor	Fair	Fair	Quite dark	Fair	72	3rd
5841	54	600	236	254	Very good	Very good	Good	White	Very good	23	2nd
5842	55	560	220	255	Good	Good	Good	Very White	Good	17	1st
5843	56	600	234	256	Fair	Fair	Coarse	Yellow spots *	Fair	6	1st
5844	57	580	215	270	Fair	Fair	Fair	White	Fair	31	2nd
5845	58	560	226	248	Good	Very good	Good	Very White	Very good	17	1st
5846	59	500	226	221	Fair	Good	Fair	White	Fair	35	2nd
5847	60	560	218	257	Fair	Good	Fair	Cream	Good	29	2nd
5848	61	540	210	257	Fair	Good	Fair	White	Fair	34	2nd
5849	62	540	209	258	Good	Good	Fair	Yellow (soap)	Fair	26	2nd
5850	63	540	193	280	Very good	Very good	Very good	Very White	Good	28	2nd
5851	64	580	212	274	Fair	Good	Fair	White **	Good	30	2nd
5852	65	580	231	251	Fair	Fair	Poor	Dark (bad)	Fair	96	3rd
5853	66	540	209	258	Fair	Good	Good	White	Fair	46	2nd
5854	67	560	205	273	Fair	Good	Fair	Dark	Fair	43	2nd
5855	68	540	216	250	Good	Good	Poor	Dark	Fair	88	3rd
5856	69	520	214	243	Poor	Fair	Poor	Very dark *	Poor	113	3rd
5857	70	540	196	276	Poor	Fair	Poor	Very dark	Good	89	3rd
5858	71	540	212	255	Fair	Good	Good	White	Good	28	2nd
5859	72	560	197	284	Good	Good	Fair	Cream	Good	43	2nd
5860	73	500	218	229	Poor	Poor	Poor	Very dark	Poor	127	3rd
5861	74	540	211	256	Poor	Poor	Fair	Cream	Fair	29	2nd
5862	75	520	208	250	Good	Good	Poor	Dark (bad)	Fair	73	3rd
5863	76	520	220	236	Fair	Fair	Fair	White	Fair	38	2nd
5864	77	520	208	250	Fair	Good	Fair	Dark	Fair	72	3rd
5868	78	540	217	249	Fair	Good	Good	Cream	Good	65	2nd
5869	79	560	213	263	Good	Good	Good	Cream	Good	66	2nd
5870	80	580	210	276	Good	Good	Good	White **	Good	71	3rd
5871	81	560	216	259	Good	Good	Fair	Cream	Good	62	2nd
5872	82	560	220	255	Good	Good	Good	White	Good	36	2nd
5873	83	520	205	254	Good	Good	Poor	Dark	Good	53	2nd
5874	84	540	216	250	Good	Good	Fair	White	Good	26	2nd
5875	85	580	215	270	Fair	Fair	Fair	White	Fair	31	2nd
5876	86	580	227	256	Poor	Fair	Poor	Dark	Fair	45	2nd
5877	87	540	230	235	Fair	Fair	Good	Fair	Good	41	2nd
5899	88	600	213	282	Fair	Good	Very good	Very White	Good	18	1st
5900	89	600	225	267	Good	Good	Very good	Very White	Good	63	2nd
5901	90	580	223	260	Fair	Good	Good	Cream	Good	108	3rd
6035	91	640	237	270	Good	Good	Very good	Cream	Excellent	8	1st
6036	92	620	217	286	Good	Good	Good	Cream	Good		
Maximum		640	244	288							
Minimum		460	186	195							
Average		559	217	258							

* 1st class flour has low count of wheat hairs.
2nd class flour has medium count of wheat hairs.
3rd class flour has high count of wheat hairs.

** Soda or yellow spots.
† Flour dirty.

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Bread vs. Vitamins

By C. B. MORISON
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Bread, especially white bread made from highly milled patent flour, has always been a favorite target for the slings and arrows of the food crank and vox-popular scientist.

It is very easy to make white bread the object of sensational attacks which lend themselves readily to headlines and exaggerations in the press and popular periodicals because the average reader has little or no knowledge or appreciation of all the facts surrounding the problem of the nutritional properties of bread and its role in the dietary.

Lately the nutritional bolshevik whose attitude toward traditional conceptions in popular feeding is similar to that of his political brethren in matters constitutional, has obtained considerable more thunder for his attack on white bread from recent investigations in nutrition which are concerned with the essential dietary factors now known as vitamins.

Formerly controversies on the respective merits of bread made from various grade of flour revolved about digestibility coefficients and deficiencies in inorganic elements to become later complicated by the recognition of differences in the nutritive properties of the proteins and recently by conceptions dealing with vitamins as factors in relation to metabolism and "deficiency diseases."

This has resulted in much popular bewilderment because of the fact that the problem as a whole, of the role of bread in the dietary, has been

made subsidary to the over emphasis of certain specific points that may be sensationally treated in addition to the "complete food" obsession that naturally follows:

These attacks on bread have not originated from those who stand foremost among recognized authorities in biochemistry and nutrition but for the most part come from second hand sources who have a hobby to ride or something to sell.

White bread like all other foods is not complete and balanced in all dietary essentials so that it can serve as the sole source of food over the complete life history of an animal.

Milk is the most satisfactory food in regard to its constitutents but it will not serve alone as a complete source of nutrition for the adult animal. Mattill and Conklin have recently shown that when rats were fed on cow's milk exclusively, normal growth was retarded in its later stages with failure to secure normal reproduction. Though milk is the essential and only food suitable for the young animal it is also deficient in iron and as McCollum states "if a child were confined too long to milk as its sole food it would suffer anemia for lack of iron."

It has been repeatedly shown by many investigators that there is no one natural food taken by itself as the sole source of nutrition that is not more or less deficient in some dietary essential. "The keynote to the discussion of the individual foods entering into the diet of man is the importance of using proper combinations of food." The food crank ignores this important nutritional truism and as a result, launches forth his diatribes against bread and other traditionally basic foods to the total loss of all sense of proportion. It thus naturally follows that we hear these critics condemn white bread unreservedly because it lacks vitamins and as an insidious enemy of the human race which is destroying our teeth and rapidly forming us into national malnutrition and oriental beriberi.

Wheat and its products have been intensively investigated by Osborne and Mendel, McCullum and his coworkers, Sherman and others. The proteins of the entire wheat kernel have been found to be superior to the proteins of the other cereal grains so far as is now known. Osborne and Mendel's results indicate that the proteins of the endosperm tissues from which patent flour is made are adequate for the adult maintenance of the rat but are inadequate for growth. When milk, meat or eggs is added to wheat flour the value of the proteins is greatly enhanced for growth, with greater economy in consumption. It is the opinion of these investigators that "under the ordinary human dietary conditions, the proteins of wheat are advantageously employed." The proteins of patent wheat flour may be supplemented also by soyabean flour and peanut flour.

H. C. Sherman has reported experiments with bread which show the efficiency of the protein in maintenance metabolism. "In these experiments bread furnished over 95% of the protein consumed, yet allowing the first three days for adjustment it will be seen that practical equilibrium was maintained on an intake of a little less than 0.5 grams of protein per kilo of body weight." Thus the protein of wheat bread showed as high an efficiency in the maintenance metabolism of man as would be expected of the protein of mixed diet in general. The bread was ordinarily white bread purchased from a New York City bakery. Probably the customary small amount of milk was used, exactly how

much or in what form we were not permitted to ascertain. That the bread did not contain any unusual proportion of milk or milk powder was shown by determining its content of phosphorus and calcium as well as nitrogen.

Thus it does not seem necessary to discriminate against bread protein as compared with the proteins of staple foods in general in so far as the requirements of adult maintenance alone are concerned.

The ash deficiencies of white bread may be supplemented also by the use of other foods containing sufficient calcium, phosphorus, sodium, chlorine and iodine. The addition of mineral salts containing these ingredients is justified in bread formulas using patent flour. Sodium chloride in particular as a source of sodium and chlorine should be regarded as a nutritive essential of white bread apart from its important influences on fermentation and flavor. The calcium content of white bread is higher than popularly supposed because of the use of "yeast foods," and milk and its products in the formula. Milk again is noteworthy as a supplement for the calcium and phosphorus deficiencies of white bread.

Patent flour and white bread are very deficient in the vitamins A, B, and C but again these are ordinarily supplemented by the use of proper food combinations. Both A and B can be introduced into white bread formulas very easily by the use of appropriate sources of these vitamins.

Milk again may contribute efficiently to the contents of A or fat soluble A, the anti-opthalmic vitamin. It will also furnish considerable B, the antineuritic vitamin, but this can be more readily increased by the use of certain vitamin B concentrates from wheat germ and yeast.

Vitamin C, the antiscorbutic vitamin is too susceptible to temperature and exidation to be considered in connection with white bread and it is not necessary or practical to indicate possibilities in this direction unless the type of white bread as now produced is materially changed.

The feeding of bread as the sole source of food to animals, especially white rats, has been carried on by many investigators. The facts are thoroughly established and it is interesting to note that the classical experiments of Stepp which were published in 1909 showed that bread prepared with milk was capable of maintaining adult white mice without loss of weight for a very long period of time. Stepp almost discovered and recognized the existence of what are now known as vitamins as the indispensible essentials of this diet but he regarded the unknown factors then as lipins.

The effect of milk in promoting the growth of animals was recognized by Hopkins a few years later. Historically the B vitamin has a close connection with bread and milk.

The recent experiments of Sherman and co-workers 1921-1922 on the feeding of simplified diets to white rats have shown strikingly the remarkable effects of milk in supplementing the recognized deficiencies of white flour.

When a mixture of equal weights of bread and milk, in which white bread furnished four-fifths and milk only one-fifth of the total calories (or a corresponding mixture of dry bread or flour or whole milk powder) it was sufficient for growth at practically the normal rate but not for normal reproductions.

On a ration containing the same proportion of milk but with ground

whole wheat instead of bread or patent flour, young were successfully suckled and grew to maturity at somewhat less than the average rate and in several cases produced and successfully suckled young of the third generation. When larger proportions of milk were used so as to constitute one-third of the total solids, the rest of which was ground whole wheat, the mother suckled the young without undue loss of weight with normal growth.

When ordinary milk was replaced by dried milk or when used in bread making and subjected to the temperature of baking, there was no evidence of any appreciable effect of such heating upon the growth promoting property of milk as demonstrated upon rats.

When one-half of the water used in bread-making was replaced by milk and still more when the bread was made entirely with milk, the improvement in the food value was strikingly apparent on the growing animals.

Increased rate of growth regularly followed increases in the proportion of milk in the diet from 5% to 38% of the total calories of the food. Feeding experiments with white rats using bread made from patent flour and containing various amounts of milk have been conducted by the writer in the Institute Laboratories for many months. The results of these experiments according to the graphs and photographs which have been shown you, demonsstrate the important nutritional advantage which milk possesses as a supplement to patent wheat flour, especially in relation to the proteins and inorganic constituents and in part to the vitamins A and B.

Tests in our laboratories on some of the vitamin B concentrates recommended to be used in connection with bread making, have shown them to be of no value unless used in connection with materials which must be added in sufficient quantity to supplement the proteins, inorganic constituents and the A vitamin.

Some of them are clearly misrepresentations of the facts and while they may be concentrates containing potent amounts of B, they serve no useful purpose in white bread without additional supplements to cover their own characteristic deficiencies.

One preparation we have tested is a deliberate fraud and contains absolutely no vitamins. As far as we have gone with our preliminary trials, the Vitomim Bread manufactured by the Ward Baking Company has given exceptional results as the following graph indicates. Its formula contains a vitamin B concentrate from cereal grain sources and sufficient milk to supplement the patent wheat flour protein. The inorganic constituents, especially calcium is maintained at a high plane sufficient for the requirements of our animals and is due to several sources notably the milk. Milk is also the chief source of the A vitamin.

Bakers and others who are led to buy vitamin concentrates for the purpose of increasing the food value of bread should be very careful to first ascertain whether or not it is potent in vitamins as claimed and secondly how much other material should be used in the formula to have any real effects on supplementing other nutritive essentials.

The vitamin propaganda has obscured the insistent facts in relation to the nutritive properties of white bread and no practical advantage is obtained by merely introducing a vitamin B concentrate into the formula.

White bread can however be made a more efficient and basic article of the dietary by a more extensive use of milk in the formula and for all practical purposes this is sufficient under ordinary conditions of the food supply.

Bread will always remain as it has been from the earliest times the most important energy producing food and an economical source of protein when effectively supplemented.

Homogenization Applied to Baking

By A. W. LANDSTROM
American Institute of Baking.

About a year ago a lively interest was developed in what seemed a revolutionary method of mixing dough ingredients homogenization. "Bakers Weekly" published the results of experiments performed in the laboratory using "emulsified" or "homogenized" ingredients. In the present paper I will describe experiments made here at the Institute during a study of this process and discuss some of the results obtained. Complete data regarding these experiments has been published in Baking Technology for December 1922 and January and February 1923.

Although the process of homogenization is not new, having been in use in the dairy industry for a number of years, its application to baking is recent, dating back to the small scale experiments mentioned. Since that time several commercial installations have been made but I have been unable to obtain accurate data regarding them.

Homogenization is an attempt at obtaining a more uniform admixture of the shortening used in a dough throughout its mass.

Any method which results in the thorough mixing of the ingredients of a dough batch should be an important factor in the production of better bread. Homogenization of the shortening, malt extract, sugar, milk, and water produces a highly uniform mixture which ought proably to have the effect not only of producing better bread, but in addition, of influencing favorably the prevention of losses due to evaporation of water and other volatile substances from the bread. The uniform distribution of fatty compounds such as shortening in the dough, is probably a factor in this problem.

The materials which are homogenized are the milk powder or condensed milk, sugar, malt extract, shortening and part of the water required by the "Baker's Weekly"—April 8, 1922. P. 58., formula in use. These ingredients are put into a mixing or agitating tank, heated to a point where the shortening used is liquid and then pumped to the homogenizer. Several different types of machines are available for this purpose, differing in design, but all accomplishing the same purpose, namely the breaking up of the shortening or fat into minute particles and distributing these uniformly throughout the aqueous liquid of the dough batch. In our work we used a machine which emulsified these ingredients by forcing them through a series of small grooves or slots under a pressure of about 1800 pds. to the square inch.

The mixture produced by the "homogenizer" has been popularly

referred to as an emulsion. As a matter of fact it is a true emulsion at ordinary temperatures only in cases where the shortening used is itself a liquid under these conditions, since by definition an emulsion consists of one liquid dispersed or finely divided and uniformly distributed throughout another liquid. A true emulsion would be produced say if an oil such as cotten seed oil were used. When a shortening solid at ordinary temperatures is used, a suspension results a the finely divided particles of shortening are in reality in a solid state. Whether there exists a real difference detectable by practical observations between suspensions and true emulsions of shortening and other baking materials is a matter for further study. Since the shortening used in this study was solid at room temperature we are in the present discussion dealing with suspensions and not emulsions.

Various claims have been made for the process and in the previous work referred to from which we quote directly we find that the results of these early experiments showed:

1. "That from 1 to 2 per cent greater absorption was obtained with the emulsion dough."

2. "That the dough in which emulsion was used, as a rule, developed greater volume in the same period of time."

3. "That the dough containing the emulsion as a rule, came to a greater volume in the oven, it produced bread having somewhat better symetry, better color of crust, better grain, texture, color of crumb and keeping quality."

4. "____and from the work carried on so far we have observed that the emulsion loaf carries from 1 to 1½ percent more moisture."

In our wrok we attempted to determine how many of the above observations would be confirmed under practical conditions. Our experiments have been made in three sets under conditions as closely controlled as was possible in a bake shop. These conditions varied somewhat between the different sets of experiments but were practically constant in any one series. We first studied the application of this process in our school shop varying the absorption of the doughs, keeping rather complete sets of data. This was in the nature of preliminary work and was intended to show any outstanding features of the process which might serve as a basis for further work. One of these features which seemed worthy of further study was the apparent tendency of "homogenized" bread to lose less weight on storage than bread made in the usual fashion. This further work seemed to confirm our preliminary observations. Up to this point we had been using the equipment of the School of Baking of the Institute. Mixing had been done in a medium speed machine. We had expected that homogenization of ingredients followed by mixing in a slow or medium speed machine would give a more uniform dough and better bread than slow or medium mixing alone. The results of our first two sets of experiments indicated that this was the case. Whether or not the application of homognization to high speed conditions would

result in a marked improvement was rather difficult to predict because of the well known efficiency of this type of machine. Our third series of experiments was therefore made in a large representative commercial bakery. In this work the sponge and dough method of bread making was used to accommodate the shop schedule, while in our previous work at the Institute straight doughs were used. The result of this latter work although not strictly comparable with the early work we believe to be representative and to give a fairly accurate indication of the effect of homogenization in a high grade commercial shop using the sponge and dough method and high speed mixing.

Preliminary Experiments.

Three sets of experiments were made using 150 pounds of flour and three different absorptions; the normal as determined in the usual way, the normal plus 2.5 percent and 5.0 percent water respectively. Doughs were run using homogenized materials and checked by control doughs run under conditions as nearly alike as could be obtained in practice. The formula used is in the case of the normal absorption doughs practically the same as an all milk formula. Expressed in percent it is as follows:

Flour ______Mother Hubbard ______	100
Sugar ____________________________	2
Salt _____________________________	1.75
Yeast ________________________	3.
Water ____________________________	61.0
Shortening ____ M. F. B. __________	2.
Whole Milk Powder ______________	7.9
Malt Extract (Diamalt) ___________	1.
Yeast Food (Arkady) _____________	.25

One-fourth of the water necessary for a complete formula was put into the agitating tank of the homogenizer with the milk powder, malt extract, and sugar and agitated until a homogenious mixture resulted, meanwhile bringing the temperature to about 100o F. The shortening was added and agitation continued until this had melted. The mixture was then run through the homogenizer at a pressure of 1800 - 2000 pounds per square inch, cooled and stored for use next morning.

Emulsions were made by the following procedure. All materials were analysed for moisture and this determination was also made upon the doughs and the resulting bread. The following observations and data were kept.

Absorption
Percent H_2O Dough "out of mixer."
Fermentation Room conditions Temp. average.
Fermentation Room conditions Humidity average
Temp. dough out of mixer.
Temp. dough average during fermentation period.
Fermentation loss per cent.
Fermentation period minutes.
Average H_2O content of dough to bench.
Temp. Shop.
Humidity shop.
Temperature Proof Box, Average.

Time of Proof, minutes.
Temperature of Oven.
Time of baking, minutes.
Oven loss, per cent.
One hour loss, per cent.
24 hour loss, per cent.
Number of loaves.
Avg. weight of loaves, 1 hr. old ℔.
Avg. H_2O content of bread 1 hr. old.
Avg. volume of loaves in c.c.
Avg. volume, c. c. per ℔ of bread 1 hr. old.
Retention factor, per cent.
Calculated retention factor, per cent.
℔ of bread per 196℔ bbl. of flour.

Bread was scored by two members of the Institute staff using the Institute score card. The results of the first series of experiments in general confirmed the statements of earlier workers that the absorption of a flour is increased by the use of emulsified ingredients. The resulting increased yield was however, variable although quite clearly in favor of homogenized bread. A rather paradoxical condition was encountered in that throughout the doughs made with homogenized ingredients seemed more slack out of the mixer than the control doughs, but tightened up during fermentation to the same consistency as the controls and further yielded greater weight of bread per barrel of flour. This is after all, only a logical result if we consider that the finely divided particles of shortening uniformly distributed throughout the water can readily come in contact with granules of flour and so prevent the immediate contact of these with water, whereas in the control doughs, mixed in the ordinary manner, the flour is given about ⅔ of the mixing period in contact with water or water soluble substances alone.

Slight variations in yeast strength and temperatures of doughs made it impossible to draw any conclusions as to the effect of homogenization on the time of fermentation. It seemed however that this factor was little affected. The difference between the fermentation losses on doughs in which homogenized materials were used and those prepard in the usual manner were so slight that again nothing definite was indicated.

The data collected show definitely that homogenization decreases baking losses, i. e. losses of water and other volatile substances in the oven due no doubt to the fineness of division of the particles of shortening and their resulting more uniform distribution in the dough. The yields of bread weighed one hour out of the oven were correspondingly increased. This decreased oven loss and increased yield was most evident at the normal absorption of the flour, a difference of ten pounds being noted here while in doughs containing 2.5 and 5 per cent more water than the normal, this difference dropped to one and three pounds respectively. It is significent that the difference between the retention factor determined experimentally on "homogenized" doughs and that calculated on the assumption that all water added above the normal absorption of the flour should bake out is very nearly constant on the three sets of experiments performed, while for "non homogenized" doughs this varies. This is a possible indication that as far as yields are concerned homogenization tends toward producing more uniform and reproducible results. These experi-

ments showed further that homogenization produces bread which scores higher, the chief difference found being in the better grain and texture of the loaf.

The volume of "homogenized" bread in general showed an increas over that made by the usual procedure, and a better break and shred, giving a loaf somewhat more attractive in external appearance. The color of the crumb was in general, better. No increase in flavor or taste was observed although during mixing those doughs containing homoegnized materials smelled more strongly of malt than the control doughs. It was difficult to determine any increased keeping quality of the bread since bread baked from the control doughs was excellent in this respect. Possibly with a formula containing smaller amounts of whole milk the effect on keeping quality of the finely divided fat of the emulsion would have been more pronounced. A preliminary study was made to determine weight losses of wrapped bread both from homogenized and control doughs. The results obtained were not considered representative and this work was made the basis of another series of experiments.

Moisture determinations on finished loaves did not agree with the data obtained on yields. Since it is very difficult to pick two representative loaves from a batch of about 230 baked in a 250 loaf oven we believe that these moisture data should be given relatively less weight than the data on yields.

A second series of experiments was made with the though of studying under like conditions weight losses of bread made in the usual manner and with homogenized materials. The formula was changed slightly from that used in the first series in that skimmed milk powder was substituted for whole milk powder and another flour was used. The normal absorption and the normal plus 5% water were studied. Weight losses of bread both wrapped and unwrapped were investigated. The following data were recorded:

Absorption, per cent.
Temp. of dough, deg. Fahr.
Ferm. period, minutes.
Baking period, minutes.
Oven temp., average.
One hour loss, per cent.
Storage conditions, temp.
Storage conditions, humidity.
Wrapped bread, loss for 23 hsr. after 1st hr.
Unwrapped bread, loss for 23 hrs. after 1st hr.
Storage conditions, average temp.
Storage conditions, average humidity.
Wrapped bread, total loss 24 hrs. from oven.
Unwrapped bread, total loss 24 hrs. from oven.

Materials were analyzed as previously.

The paper used for wrapping bread was of the shiny, self-sealing variety, unprinted. The average weight of one square foot was found to be 0.129 oz. with the setting of the wrapping machine employed the size of the sheet of paper used per loaf was 1.774 square feet. Upon analysis it was found that 24.63 per cent of the weight of this paper was wax (ether soluble material.)

The preliminary experiments already discussed had indicated that homogenization materially cut weight losses over storage periods of one and twenty four hours. These later experiments strikingly confirmed these observations. The homogenized bread showed a loss in weight the first hour out of the oven of about one per cent less than the control, in the case of both the normal and the normal plus 5% doughs. An interesting tendency was noticed, namely that it appears as if the protective effect of homogenization upon weight losses is greater during the early stages of storage. In fact it is of such a magnitude that in spite of the greater loss which a storage period of 23 hrs. after the first hour shows for "homogenized" bread as compared with the control the total losses for 24 hrs. are less in the case of the former. An interesting observation might be made here regarding one of the advantages to the baker of wrapping bread, the unwrapped bread losing for the 23 hrs. after the first hour about 4% more in weight than that wrapped.

The work thus far discussed was done under medium speed conditions. The results seemed to us to warrant trial of the process in a shop where high speed mixers were used and this was accordingly done. It was necessary to use the formula and procedure of the shop so that the data obtained on this work are not strictly comparable with those previously discussed. However they seemed of enough importance and representative enough to warrant publication. The formula used for these experiments contained 6% sweetened condensed milk and 2.4% lard. The absorption of the sponge was 60 % and the dough 62%. Bread was baked in a Baker Perkins travelling gas fired oven equipped with eight thermo-couples for recording temperatures. It was impractical to study total yields because of the size of the batches used, 500lb of flour being used for each dough; instead we chose to study the effect upon absorption as shown by the moisture of the bread produced. This was entirely feasible since the construction of the oven and the accurate temperature control possible made control of the baking times simple. Sponges were set in the conventional fashion and homogenized ingredients added at the dough stage. The following data were observed:

1. Absorption, per cent.
2. Temp. dough, deg. F.
3. Moisture per cent. Dough out of mixer
4. Time of baking, minutes.
5. Temp. of oven, (Average) deg. F.
6. Oven loss (per cent of dough to pan.)
7. Storage temp., deg. F.
8. Storage Humidity, per cent
9. One hour loss, (per cent of bread one hour old.)
10. Av. moisture, bread one hour old.
11. Volume of loaf c. c.
12. Volume of loaf c. c. per pound of bread one hour old.

Bread was scored as usual by two members of the Institute staff. An inspection of the data obtained showed that no great differences due to homogenization when used in conjunction with high speed mixing were obtained. in oven losses or weight losses on storage of bread for one hour after baking. Homogenization however, appears to produce bread which scores higher under these conditions, both the external and internal scores being improved by the application of this process. The average "hom-

ogenized'' total score was $92\frac{1}{4}$ as opposed to $87\frac{1}{2}$ obtained bu usual practice.

It does not appear from our data that under these conditions the moisture content of the baked loaf (one hour old) is much affected by homogenization as the homogenized loaves showed an average moisture content of 36.87% as opposed to 36.80% obtained from loaves where ordinary mixing procedure had been followed. These moisture data we consider representative, as the oven temperatures were closely controlled, so that the baking periods differed on an average by only one-half mixture. Further, the arrangement of burners and the construction of the oven was such as to insure an even distribution of heat. While the above ''Oven Losses'' are not strictly losses due to baking alone, since loaves were weighed as taken from the moulder, we believe they are representative and comparable since the loaves were treated similarly from this point in the process. The loss in weight due to proofing in an atmosphere so highly charged with moisture as is that found in a modern ''steam box'' would be negligible when compared with the loss due to baking.

To sum up—it appears that under slow or medium speed conditions the application of homogenization to bread baking not only produces a loaf which scores higher, but further appears to favorably affect the yield of bread obtained. It also seems to reduce weight losses of baked bread, especially is this true for the first hour of storage. In the case of high speed mixing yields seem not to be affected. In all of this we have not considered the questions of convenience or cleanliness. In a bread shop large enough to warrant the homogenization of considerable quantities of materials, the time and labor saved in the dough room is an important item. In a plant of this size one batch sufficient for the entire day's run could be weighed out, homogenized and withdrawn easily and cleanly as needed, eliminating the tedious weighing of individual batches of material with its attendant ''invisible loss'' and inconvenience.

Building the Quality Loaf

By O. W. HALL
American Institute of Baking.

The first thing to do when you decide to build is to draw a plan and then select a site. In drawing up the plan it is a good thing to get the opinion of everyone who is interested in the building.

When we decided to build a quality loaf we knew that all the bakers in the country would be very much interested in the result and so might like to help in drawing plans. With this end in view we sent out questionaires to bakers in all parts of the country asking them what their idea was of the height of perfection in a loaf of bread.

We received answers from more than 100 bakers and from these answers we proceeded to draw our plans. After we had the plans we looked for a site on which to build. There was only one site available. This site was the bake shops of America. On going out to view it we found that our site had already been occupied.

Somebody had built a loaf of bread upon it already. Instead of destroying the building that we found there we decided to remodel it. About

the first of last December we commenced active operation in remodeling. We adopted a systematic plan of bread scoring, under which bakers send sample loaves to their bread to the service department regularly to be scored and criticised, and to receive suggestions for their improvement. The bakers are supplied with special labels, baked on the bottom of the loaves, so as to insure getting the regular run of bread and not selected loaves. Up to the present time we have supplied about ninety bakers with cartons and labels to be used in sending in their bread samples.

These bakers are located in all parts of the United States, and we have one in Halifax, N. S. The sample loaves are sent in at intervals varying from every day to once a month.

I am going to tell you a few things that seem to be common practices among bakers, and that are responsible for most of the poor quality bread that is being sold. To start at the beginning of a loaf of bread we find that some bakers experience considerable difficulty in selecting their flour. How with so many cereal chemists supervising the milling of so many high grade of flour, it ought not to be hard for every baker to get a flour that exactly suits his needs.

One of the most common faults I find with the average baker's selection of flours is that he selects too many of them, and then does something that he calls blending. This consists of putting two or more flours into a mixer and running the machine a few minutes before adding water and other ingredients. I have also known the so-called blending to be done by putting the water and other ingredients into the mixer first, starting the machine, and then dumping the various kinds of flour in separately.

I should say that in this case the water, salt, sugar, yeast, and anything else used besides flour, would be well blended, but I have seen bread made this way that had a *different kind of grain and color for each flour used,* including the dusting flour.

There was one baker who sent in some loaves asking for help to eliminate a bad streak through the crumb. After examining the bread I asked him to send me samples of the flour he was using. In due time I received four samples of flour from him with information as to the way he was blending them.

I found that three of these flours were so nearly alike that they could be put together in any proportions and a good loaf could be made with them. The fourth one, however, was very much darker in color and also so musty that the gluten was nearly destroyed.

I see no objection to the blending of flours if a baker is equipped to do it properly and knows how to select the right flours to blend, but if he is not so equipped he will do much better to use one flour at a time.

The amount of water or the absorption to be used in making up doughs is another source of trouble to a great many bakers. The majority of flours on the market at the present time require 59 or 60 per cent water to make a dough of the proper consistency but I know of bakers who are using these flours with 51 and 52 per cent of water. The result is a very tight dough that ferments slowly, does not handle well, and makes a poorly formed loaf. The grain is coarse and uneven, with thick cell walls and a harsh texture.

On the other hand there are some bakers who use these same flours and put in as high as 65 per cent of water. Now I am not referring to

the larger shops with high speed mixers and other equipment for handling very soft dough, but rather to the small baker who has a slow-speed mixer and does not use any of the products intended to increase absorption.

The main idea in using so much water is of course, to get more loaves per barrel of flour, and these bakers think they are really doing it. I believe that if they would keep an accurate record of the amount of dusting flour used they would find that their bread is not quite so good as they final absorption is just about normal, while the number of loaves obtained is about what would be expected from the total amount of flour used.

Besides kidding themselves about their yield such bakers generally find that their bread is not quite so good as they would like to make. Bread made in this way has hard lumps of raw flour, scattered through the crumb. There are also dark streaks of dusting flour which will show you just exactly how the loaf was moulded.

These faults are also accompanied by a flavor of raw, unfermented flour.

There is one other bread ingredient that I am going to mention, and that is yeast food. There is no doubt about the beneficial effects of yeast foods if they are properly used, and I don't suppose any baker ever bought any of these products without being told how to use them. Still there are plenty of bakers using yeast foods together with the usual amount of yeast, mixing their doughs at temperatures anywhere from 80° to 84°, and allowing from two to three hours for the first punch and giving two or three more punches with corresponding times for each. The result is, of course, a very old dough, and bread that crumbles upon the slightest touch.

There are also some bakers who miss the idea of yeast foods so far as to run long time sponges with a comparatively large amount of yeast and then put their yeast food in the dough after the fermentation is practically finished. I have been told by bakers who do this that the object of the yeast food in the dough is to get a good oven spring. If they would put it in the sponge it would help their fermentation and still be present to give a good oven spring.

The two factors that are probably responsible for the greater part of the poor bread are time and temperature. There are many bakeries that have absolutely no temperature control. The temperature of their doughs varies from 75° to 85° and are punched, and taken on a set time schedule. The result of this practice is as many different qualities of bread as there are different temperatures, and most of these qualities are poor.

Probably the most common fault in the matter of temperature is mixing doughs too warm. There is a certain coarse grain and dark color which nearly always results from a warm dough. There is one baker who sends in bread regularly that had combination of grain and color. I told him that he ought to mix his doughs cooler. He replied that he had been mixing at 82° but had changed o 80°. His bread still seemed to be made from a warm dough as I asked him to send his thermometer in to be checked up. He did so. Mr. Landstrom, of our staff, found that it was several degrees off, and told him how to apply the necessary corrections.

In less than a week after this I received a letter from the baker in which he said that his bread was much better. When I received his next sample of bread, however, I found that he had made no change in his

time after reducing his temperature, and that his dough was young.

It is very common to find bakers who do not properly divide their time. For instance, I had a formula a few days ago from a baker in one of the Southern states. His formula was well balanced and contained yeast food, but he was allowing his dough three hours for the first punch and 30 minutes for the second and sending it down in 15 minutes. This division of time would be almost certain to result in a very old or a very young dough, because if the dough required three hours for the first punch the remaining time was not nearly enough. On the other hand three hours was too long for the first punch, it was too old then and would be too old all the way.

In this case the answer was very clean,—the bread showed plainly that the dough was too old. Other bakers will give the dough the first punch in one hour and then allow two or three hours for the second. There should be some definite relation between the times of the various punches. One system is to allow 60 per cent of the total time for the punch, 28 per cent for the second, and 12 per cent for the third.

Another rule, which is practically the same thing, is to allow the second punch one-half the time of the first, and the third a half the time of the second. Both these rules give good results except when yeast food is used, and then the punches must be governed by the condition of the dough.

There are two things that I would like to impress upon every baker, One is that he ought to have some kind of twenty-four inch guage, by which to properly divide his time and the other is that the principal working tool of a baker is the thermometer.

Checking Protein Results

By M. R. WARREN
Quaker Oats Company, Cedar Rapids, Iowa.

The subject of proteins has been taken up from all angles so thoroughly that apparently to some the method is so well defined or described that all one has to do is to take a sample at hand, weigh it up, put it in a flask, digest and distill it, then titrate and read the result. In fact that is what is done but there are certain rules or laws which have been proven without doubt in the past years to be very important and cannot be disregarded for any reason if an accurate result is to be obtained.

Our attention was called to this subject more especially because it was our duty to check up our shippers when the product was bought on a guaranteed analysis. In doing this work we found that we were checking very closely with some laboratories, but not so with others. There wasn't any question but that someone was not getting correct results and we wanted to know whether or not we were the ones. So in November of last year we selected two samples of wheat, one of which was representative of the southwest and one of the northwest. We selected samples which seemed to be very uniform in color and size of berry. Of these two samples, about two bushels, were cleaned and placed into large tin

cans with tight fitting covers, which in turn put in the laboratory.

It is our good fortune to have four laboratories of our own which at regular intervals exchange samples for analysis. We also have an outside laboratory which receives duplicates of all of these samples and is the referee in case of any difference. It was our plan to send to each of these laboratories at the same time a sample of the two wheats, this to be repeated every week or so, but each time the sample should be sent with a different number so that the other chemists might not suspect they were getting a duplicate of a sample they had received before. With this system worked out we started sending out the samples on November 28, 1922. This was continued until May 15, 1923 with the result that fifteen samples of one were sent out and fourteen of the other to each laboratory. All of the five laboratories were using the same method, except that the referee laboratory was using 1 hour longer digestion. The method used is as follows:

> Weigh out 1 gram of sample which has been ground so it will go through a 1 mm round hole sieve into 500 c. c (or whatever size flask ordinarily used) Kjeldahl flask, and add 6.5 gr. Sodium or Potassium Sulphate (weighed roughly,).7 grams of mercuric oxide (weighed roughly,) or its equivalent of Metallic Mercury and 25 c. c. of Sulphuric Acid C. P., and digest for two hours, turning the flame so that the solution clears in about 30 minutes. However, do not turn the heat off until the samples have digested for 2 hours. At the end of this time, turn heat off and cool. Add roughly 250 c. c. of water, some Metallic Zinc, 25 c. c. Sodium Sulphide solution (40 gr. per litre) and enough Sodium Hydroxide solution to make Alkaline connect and shake. Distill until the flasks begin to bump, or about 45 minutes to 1 hour.

This method is practically the same as the one worked out by A. E. Paul and E. H. Berry in 1921, and which can be found along with the report of their work in the August 15, 1921 issue of the Journal of the A. O. A. C. Their method did not specifically state some of the amounts of chemicals which were to be used, but we thought best that every detail should be the same. It was, and is not our aim at present to go beyond the bounds of the official method but rather work in definite details in their general method. Below will be seen the results of these laboratories which we saw fit to letter A, B, C, D, and E.

Sample "A"

LABORATORIES

Date	A	B	C	D	E
11-28	14.15	13.80	14.00	14.21	
12-14	14.05	13.90	14.20	14.20	
1-12	14.00	14.10	14.05	14.13	
1-23	14.00	14.00	14.20	14.15	
2-2	14.00	14.20	13.80	14.05	
2-6	14.00	14.00	13.85	14.05	
2-13	14.00	14.20	14.10	14.13	
2-25	14.13	14.10	13.90	14.05	14.09

3-2	14.00	14.10		14.05	13.89
3-6	14.00	14.00	14.05	14.13	13.73
3-20	13.95	14.00	14.00	14.05	14.09
4-6	14.00	14.00	13.90	14.02	13.85
4-17	14.00	14.00	13.90		14.05
4-30	14.00	13.95	14.05		
5-9	13.90	14.00	14.15		14.01
5-15	14.00	14.00			

Sample "B"

LABORATORIES

Date	A	B	C	D	E
11-28	13.05	12.90	13.05	13.10	
1-12	12.95	13.10	12.90	13.18	
1-23	12.95	13.10	13.20	13.18	
2-2	12.90	13.00	12.70	13.11	
2-5	12.86	12.90	13.05	13.02	
2-13	12.86	13.10	12.85	13.00	
2-25	12.95	13.00	12.90	13.00	12.98
3-2	12.95	13.00		13.10	12.99
3-6	12.80	12.80	12.65	12.70	12.86
3-20	13.00	12.90	12.95	13.00	13.02
4-6	12.90	13.00	13.00	13.05	12.98
4-17	13.00	13.00	13.00		12.90
4-30	13.00	12.95	13.00		
5-9	12.95	13.00	13.10		12.94
5-15	13.00	12.90			
Aver.	14.01	14.02	13.99	14.10	13.96
Max	14.15	14.20	14.20	14.21	14.09
Min.	13.90	13.80	13.80	14.02	13.73
Var.	12.94	12.97	12.95	13.04	12.95
Max.	13.05	13.10	13.10	13.18	13.02
Min.	12.86	12.80	12.65	13.00	12.86
Var.	.19	.30	.45	.18	.16

It must be remembered that none of the laboratories except "A" knew the samples were from the same lot of wheat. "A" happening to be our laboratory,, of course, could not very well be kept from knowing. The average of all determinations made on sample "A" was 14.02 and on "B" 12.97. 54 of the 65 determinations checked within .15 of the average on sample "A" and 53 of the 61 on sample "B," or 83% checked within the experimental error on "A"; and on sample "B" 86.8% checked.

Seeing how well we were checking with a single method, we decided in March to send out sealed samples to 25 representative laboratories both milling and commercial. The instructions accompanying the samples were simple; namely, use your own method in running protein and moisture but give the method in your report. The results of the work are below giving methods, time of digestion and distillation.

1.

In this work as usual we use the regular Kjeldahl method with 1 gram

of sample, 15 cubic centimeters of Sulphuric Acid, .7 grams of Mercury, a little Permanganate of Potash with Concentrated Soda and Sodium Sulphide as required.

We collect the distillate in a decinormal Sulphuric Acid solution, using Cochineal as indicated. The time required for digestion is approximately 35 minutes and for distillation about 40 minutes. For moisture we dry in an electric oven from five hours to over-night, depending on conditions. The temperature of the oven is approximately about that of boiling water.

We grind the samples for our determinations in a small hand-mill like a coffee mill. For the protein we have it fine enough to get a uniform sample of the product. For the moisture determination we do not grind so hard as there is danger of losing moisture.

2.

Method Used A. A. C. C.

Digestion, 55 min. - 60 min.
Distillation, 25 min. - 30 min.
Gas used throughout.
Fineness No. 20 sieve.
Moisture Electric oven 103 C. Time 4 hours.

3.

We use the Kjedahl-Gunning method for nitrogen using 2 grams of the ground sample, 10 gams Potassium Sulphate, 0.5 grams Copper Sulphate and 25 c. c. of Sulphate Acid. The digestions are carried out on home-made electric heaters, which are rather slow. It takes about 40 minutes for the mixture to clear and the digestion is continued for an hour after that. After cooling we dilute with 270 c. c. of water, and a fragrant of granulated zinc, make alkaline and distil over Gilmer Heaters. The distillation is continued until the mixture begins to bump which requires about 45 minutes. The tistillate is collected in 50 c. c. of decinormal Sulphuric Acid, standardized against Sodium Carbonate. Decinormal Sodium Hydrate is used for titrating the excess of acid the indicator being Sodium Alizarin Sulphonate.

We usually grind our Whole Wheat samples by passing once through a No. 1 Arcade Flour Mill. The ground sample easily passes through a 30 G. G. with the exception of a portion of the bran which is not ground sufficiently fine to pass the sieve.

We determined the moisture on the unground samples by the Brown-Duvel method and on the ground portions by drying in a Freas oven over night at a temperature of 103 degrees C.

4.

The seal was broken on the cans which might cause a variation in moisture, and the moisture was determined on the meal ground to 50 mesh. I have found this to cause a difference of over one per cent in moisture on grain. However, I presume you want the moisture only for calculating the percentage of protein.

The protein was determined by approved Gunning method. 50 minutes digestion. 30 minutes distillation. Gas used for heating.

The moisture was determined in electric oven 105 degrees for five hours, on ground samples.

5.

The moistures were obtained in the Mojoinner Vacuum Oven in 30 minutes and checked 75 D. Centigrade. The proteins were determined with gas burners.

We grind samples fine as flour.

6.

We use the mercury and sodium sulphate method in determining proteins. Samples were ground fine but not pulverized. Time of digestion was was one hour; and distillation 25 minutes. Gas heat was used in both processes. Moisture was determined by Freas vacuum oven on a ground, five gram sample; dried to its maximum moisture content. Air drying would be approximately .7% less than reported above.

7.

Method used for protein is the approved method of the American Association of Cereal Chemists as outlined in the Manual of Methods of August, 1922, under PROTEIN (b) Kjeldahl-Gunning.

The method used for determining moisture is the method of the Association of Agricultural Chemists. **Vacuum oven at 100 degrees C to** constant weight, covered aluminum dish.

Samples for protein were not ground.

Samples for moisture were ground on a motor-driven coffee mill, to about the fineness of graham flour.

Length of time of digestion, 1 hr. 15 minutes.

Length of time of distillation, 50 minutes.

Gilmer Electric heaters were used for heating.

8.

The moistures were run in a Freas Electric Oven over night at 102 degrees C. They were ground just fine enough to crack the berries open.

The protein was run by the Kjedahl method as given in the approved methods, using mercuric oxide as catalyzer and pumice stone as ebullition agent. The wheat was ground to a very fine homogenious meal on an Arcade wheat grinder.

Gilmer Electric heaters were used by both digestion and distillation. The total time of digestion was about forty-five minutes, making sure that it was heated at least twenty minutes after the solution had cleared. The distillation was also continued for forty-five minues.

9. No report

10.

Moisture was determined by drying 5 hours at 105.
Protein by mercury, sodium sulphate method.

11.

Determinations made on finely ground uncleaned samples.
Moisture determinations made in Freas vacuum oven at 98 degrees C at 29 inches.
Protein digestion over gas, 1:15.
Distillation on electric units, .45

12.

Moisture was run on Brown Duvel Tester as well as in the Freas Moisture oven. The latter results on A were .39 higher and on B .34 higher. The samples in the Freas oven was ground.

Protein digested, 30 minutes.
Protein distilled, 20 minutes.
Electricity was used.

13.

We use the Kjeldahl-Gunning method.

Moisture was determined in a Despatch drying oven at 104 degrees C, keeping the wheat mix in it for four hours. We ground our sample to a floury consistency, the particles would go through a No. 50 sieve. The length of the digestion is one hour and 45 minutes; the distillation 40 minutes. We used gas as a source of heat.

14.

Moisture-Freas Hot Air Oven, 5 hours 103° C.
Moisture Dish-aluminum cup with cover, 2″ x 1″.

Protein.

Nitrogen x 5. 7.
Method, Kjeldahl.
Digestion, 1 ¾ hours.
Distillation, 40 minutes.
Gas used.
Kjeldahl flasks, 650 c. c.

15.

Specifications for Proteins.
The Meal was very fine.
Used the Gunning Method (Using Copper Sulphate.)
50 minutes for digestion.
Electricity on digestion and distillation.
Used the Brown-Duvel Moisture Tester on whole wheat for moisture results.

16. No Report.

17.

The samples reported herewith were not cleaned.

The protein was run by the Kjeldahl-Gunning Method, using Copper Sulphate in digestion. The moisture was run in an Electric oven without vacuum. The samples were ground to about a number twenty powder. The protein digestion occupies about thirty minutes and the distillation about the same time, using gas for heat.

18.

Samples were ground through a coffee mill and were ground fine enough to pass through a number 36 wire.

Moisture determinations were made by The Approved Methods of A. A. C. C.

Protein determinations were made by the Approved Kjedahl-Gunning method.

Digestion was made on electric heaters for one hour. Distillation was also made on electric heaters. Time of distillation about forty minutes.

19.

Method used for protein determination:

One gram of sample ground to pass 20 mesh sieve was weighed into 500 c. c. Kjedahl flasks together with 6.5 grams of sodium sulphate 0.7 grams of HgO and 25 c. c. of C. P. sulphuric acid sp. gr. 1.84. Heat for digestion, gas.

Total time of digestion 2 hours, requiring 30 to 40 minutes to clear up.

After cooling, 250 c. c. of tap water was added with a piece of mossy zinc to prevent bumping.

25 c. c. of (40 g per litre) a solution sulphide was added and 70 c. c. of caustic soda. Time of distillation 50 to 60 minutes.

Method used for moisture determination.

Sample of about 4 or 5 grams weighed out and dried in Mojonnier vacuum oven for 2 hours.

20. No report.

21.

Samples were finely ground through an Arcade Mill.

Moisture obtained by drying 5 hours in air dry oven at 103 degrees to 105 degrees C. Sample 10 grams.

Proteins obtained by digesting 45 minutes in 15 c. c. sulphuric acid to which was added 5 grams sodium sulphate and ½″ cu. wire B. & S. guage 20.

Distillation required 30 minutes into N-10 sulphuric acid.

Indicator used, sodium alizarin monosulphonate.

Gas heat used throughout.

22.

Protein determinations are made by the Kjedahl-Gunning method, digested 1 hr. with gas heat, distilled 45 to 60 minutes, samples ground to pass No. 20 wire. Moisture determination was made in an electric oven of our own construction—at 100 degrees C. for 18 hours.

Protein results are not calculated to 13.5% or other figure but are on samples as received.

23.

For both tests the samples were ground to medium fineness in a hand coffee mill. We use the official Gunning method, choosing the sodium sulphate option. The flasks are heated by gas flames and digestion requires one and one-half hours. Distillation is done with boiler steam and requires 30 minutes.

Blank determinations are made with all reagents and with cane sugar as the charge. The final tiration is accomplished with Congo Red as the indicator.

Moisture determination was made in Freas vacuum oven at 105 degrees C. for 5 hours under vacuum of 28 inches of mercury.

24.

All determinations were made on samples which had been ground to a floury consistency.

MOISTURE: Approximate 5 gm. samples were placed in tared aluminum dishes, fitted with close fitting covers. Dried to constant weight at 103 degrees C. in a Dekhotinsky triple walled electric drying oven (6 hrs.)

MOISTURE (VACUUM): Approximate 5 gm. samples were placed

in tared aluminum dishes fitted with close fitting covers, dried to constant weight at 100 degrees C. in a Mojonnier vacuum oven. (28 inches vacuum 4½ hours.)

PROTEIN (N X 5 7); 1.5 gm. samples by Kjedahl-Gunning Method. Gas used for heating. Digested 1 hr. after the solution turns straw colored (approximately 2½ hrs.). Distilled 250 c. c. in about 45 min.

Indicator used: Methyl red.

25.

Wheat was ground as fine as possible at one grinding through a small hand mill. Kjedahl-Gunning method used for protein determination. Gas used for heat throughout, Flame turned low for first ten or fifteen minutes then up high enough to clear up liquid in thirty-five to fifty minutes more, then left to digest for another five or ten minutes. Sixteen cubic centimeters sulfuric acid used and about twelve grams sodium sulphate with about .07 gram piece of copper wire. Nothing used to prevent bumping during distillation. Flask was turned often during digestion to keep solid particles down in liquid. Duplicates were not run at same time.

Moisture determination made on 5 to 6 gram "grab sample" heated in Sargent hot-air oven equipped with plates in bottom to distribute heat evenly. Samples left in oven five hours.

Duplicates run at same time but set on opposite sides of thermometer.

Thermometer registered 102 to 104 degrees centigrade.

RESULTS OF THE PROTEIN ANALYSIS

COLLABORATOR	SAMPLE		TIME			
	A	B	Digestion		Distillation	
1.	13.60	12.40	35	Min.	40	Min.
2.	13.50	12.56	55-60	Min.	25-30	Min.
3.	13.88	12.70	100	Min.	45	Min.
4.	13.64	12.50	50	Min.	30	Min.
5.	13.50	12.60	--	Min.	--	Min.
6.	13.80	12.80	60	Min.	25	Min.
7.	13.44	12.28	75	Min.	50	Min.
8.	13.45	12.48	45	Min.	45	Min.
9.	No Report					
10.	13.80	12.60	--	Min.	--	Min.
11.	13.56	12.52	75	Min.	45	Min.
12.	13.50	12.40	30	Min.	40	Min.
13.	13.80	12.60	105	Min.	40	Min.
14.	13.58	12.41	105	Min.	40	Min.
15.	13.63	12.52	50	Min.	--	Min.
16.	No Report					
17.	13.88	12.92	30	Min.	30	Min.
18.	13.48	12.68	60	Min.	40	Min.
19.	14.00	12.95	120	Min.	50-60	Min.
20.	No Report					
21.	13.60	12.60	45	Min.	30	Min.
22.	13.70	12.58	60	Min.	45-60	Min.
23.	13.35	12.23	90	Min.	30	Min.
24.	13.49	12.56	150	Min.	45	Min.
25.	13.69	12.81	50-65	Min.	--	Min.

Average	13.63	12.58		Min.		Min.
Maximum	14.00	12.95	150	Min.	60	Min.
Minimum	13.35	12.23	30	Min.	20	Min.

RESULTS OF THE MOISTURE DETERMINATIONS

COLLABORATORS	BROWN-DUVEL		AIR OVEN		VACUUM	
	A	B	A	B	A	B
1.			9.0	11.6		
2.			11.87	11.8		
3.	8.8	10.8	10.00	11.9		
4.			9.70	11.85		
5.					9.90	12.00
6					9.60	11.91
7					10.03	12.30
8.			9.39	11.83		
9.						
10.			9.69	11.69		
11.					9.73	12.27
12.	9.6	11.6	9.99	11.94		
13			10.15	12.17		
14:			9.67	11.57		
15.	11.2	11.6				
16.						
17.			9.08	11.12		
18.			10.10	11.85		
19.	9.8	11.2			9.40	11.13
20.						
21.			10.10	11.65		
22.			10.20	12.03		
23.					9.98	12.00
24.			9.84	11.80	10.07	12.11
25			9.65	11.75		
Average	9.85	11.3	9.88	11.77	9.81	11.69
Maximum	11.2	11.6	11.87	12.17	10.07	12.30
Minimum	8.8	10.8	9.00	11.12	9.40	11.13
Variation	2.4	.8	2.87	1.05	.67	1.17

It will be seen that on sample "A" there is a variation of .65% and on "B" .72% as compared to .48% and .53% in the preceed ing table. We can safely say that there is some variation in method or technique which is giving us results which are not as close as could be gotten if these variables were eliminated.

When looking for the trouble our attention is called first to the great difference in the time taken up by the digestion, we have a maximum of 150 minutes and a minimum of 30 minutes, or a difference of two hours. Taking the minimum as a basis we find that the variation is equal to 400% of the total time. In the distillation we find a 200% variation in time. It is safe to conclude from these figures alone that there is something radically wrong with someone's method. Either the man using the shorter time is not obtaining all the nitrogen, or else the man using the longer time is

losing about $2\frac{1}{2}$ hours' time on each protein analysis.

We also find variations in methods which will cause serious errors or varation. For instance, one analyst did not grind the sample but rather chose to take the whole berry, while another ground the sample fine enough to pass through a No. 50 mesh wire sieve. Some used copper, others mercury, and again some used no catalyst at all, while another used Potassium Permanganate to complete oxidation after digesting.

In the distillation we find that the differences in method are not so marked, yet there are some which should be mentioned. For instance, one used no ebullition agent, one used pumice stone, while the majority used zinc.

With all these different variables in mind, it was decided to send out a second set of samples marked X and Y, these samples being duplicates of the former A and B, but unlike them in that they were ground so that they passed through a sieve having holes 1 mm in diameter. With these samples the following instructions were sent out:

Protein Report of Samples of Wheat Marked "X" and "Y"

Method:

> Weigh out 1 gram of sample into 500 c. c. (or whatever size flask ordinarily used) Kjeldahl flask, and add 6.5 gr. Sodium or Potassium Sulphate (weighed roughly .7 grams of Mercuric Oxide (weighed roughly), or its equivalent of Metallic Mercury and 25 c. c. of Sulphuric Acid C. P., and digest for two hours, turning the flame so that the solution clears in about 30 minutes. However, do not turn the heat off until the samples have digested for two hours. At the end of this time, turn heat off and cool. Add roughly 25 c. c. of water, some metallic zinc, 25 c. c. of Sodium Sulphide solution (40 gr. per litre) and enough Sodium Hydroxide solution to make Alkaline connect and shake. Distill until the flasks begin to bump, or about 45 minutes to 1 hour.

Some report that it was necessary to make some changes in method and some others made comments on results obtained. They are listed by number below:

> No. 3.
>
> Potassium Sulphide used instead of Sodium.
>
> This method gives results slightly higher (about .2%.)
>
> This method gives results slightly higher (about .2%) than does our regular method using Copper Sulphate as a catalyst.
>
> No. 11.
>
> These results are .34% higher than those obtained by our regular method.
>
> No. 24.
>
> Report a .07 and .08 higher result on this method than obtained by the Kjeldahl method.

From these two samples we got the following results. It will be stated that the same analyst was given the same number in each set of samples. However, three more laboratories were added, while a few of the first did not care to collaborate the second time.

	PROTEIN X	PROTEIN Y	MOISTURE X	MOISTURE Y
1.	13.60	12.80	9.00	10.10
2.	13.65	12.69		
3.	13.94	12.98		
4.	13.75	12.80	8.75	9.75
5.	13.60	12.60		
6.	13.90	12.80	9.70	11.00
7.	13.50	12.48		
8.	13.65	12.60		
10.	13.90	12.80		
11.	13.84	12.76		
13.	14.02	13.01	8.94	10.37
14.	13.88	12.96	9.75	10.65
18.	13.80	12.76		
19.	14.00	13.00		
21.	13.90	12.80		
23.	13.80	12.35	9.16	10.65
24.	13.86	12.85		
26.	14.00	13.00		
27.	13.95	13.00		
28.	14.05	12.90		
Average	13.82	12.78	2	
Maximum	14.05	13.01		
Minimum	13.50	12.35		
Variation	.55	.56		

In tabulating these results we find that the variation has been cut from .65% to .55% on A to X and from .72 to 56 on B to X, or about 15% and 22% respectively. It will also be noticed that the average of the results on each sample has been raised .2% of one per cent or an increase in total protein of 1.4% on A X and 1.5% on B Y. From these two comparisons we can see that by a longer uniform method we both decrease our error by not less than 15%, and increase our nitrogen found by at least 1.4% of total.

Taking the two tables again we find that if we allow .25 for a check, or approximately ½ of the variation, we find that on A we have six analysts checking the maximum and twelve the minimum; while on X we have fourteen checking the maximum and six the minimum. On B we find five checking the maximum and six the minimum; while on Y fifteen check the maximum and four the minimum. The results are more consistent and are higher on the X and Y samples. It has been said the analyst reporting the higher result on a protein test is more likely to be right, barring the errors of weight and incorrect solutions. This statement is backed up by the fact that it is very much easier to either lose a little ammonia, or break down the last few tenths of a per cent of it in the sample than to gain nitrogen due to absorption of free ammonia or by contamination. These last errors are likely to be large and irregular, while the former are more consistent.

We find that on A and B the high results were 14 and 12.95 respectively, and that on the second analysis we have not increased our maximums on X and Y to any extent, they being 14.05 and 13.01; while the minimums on A and B, 13.35 and 12.23, were raised on X and Y to 13.50

and 12.35. This indicates that the maximum had practically been reached by some in the first analysis and that by using a uniform long period, that the analysts reporting the lower results the first time had raised their results on the second analysis. In not a single instance was a lower result reported on the second lot of samples than on the first, but in each case either one or both results were higher on the X and Y samples than on A and B.

While there is nothing in the A and B or X and Y comparisons between copper and mercury as catalysts, yet we find that in the checking of the five laboratories, there is not much question as to the effectiveness of the mercury. If we refer again to the work of Paul and Berry we find under their table No. 19 that using Mercuric Oxide they obtained their maximum results when digesting one hour after clear on a sample of flour, while it took three hours after clear to get maximum results using copper sulphate. In their results they consistently get maximum results sooner with mercury than with copper.

It is the object of each and every chemist to get out the most work in the least amount of time possible, but not to sacrifice accuracy in obtaining results. Bearing these two subjects in mind—speed and accuracy—our work leads us to the following conclusions:

First.—The sample should be properly prepared, that is, should be ground fine enough that a uniform sample can be gotten. A 1 mm round hole sieve is suggested as it is now the official sieve for feed ingredients.

Second.—The method giving us the maximum results in the shortest time has been proven by Paul and Berry to be the one using mercury as a catalyst.

Third.—It is essential that the details of the method be written in and followed closely by each and every chemist. By this, we refer to amounts of chemicals and time of operation. To enumerate we would say that the amounts of the following should be specified:

A Sample Preparation.
Sulphuric Acid.
Sodium or Potassium Sulphate.
Mercuric Oxide or Metallic Mercury.
Sodium Sulphide,

B and the time of digestion and distillation be within certain limits.

Kjeldahl Experiments

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These experiments were undertaken with a view of finding some organic salt with a normal amount of nitrogen, which could be used as a check on kjeldahl determinations. An organic salt was desired as then the determination would be more comparable to the determination of nitrogen or protein as generally employed in cereal laboratories, or, in other words, there would be the same **charring effect with a cetain period** necessary for clearing of the digestate with a consequent necessary amount of digestion with completely converted nitrogenous compounds

into ammonia salts. A salt was desired which would give the maximum theoretical nitrogen in the shortest digestion period employed in cereal laboratories as well as one that would not easily lose this nitrogen when digested for comparatively long periods.

In the investigation of each salt as taken up, the first idea was to determine if the percentage of nitrogen was constant for periods of digestion from the shortest to the longest known used in this work. Where any great variation in nitrogen content under these varying conditions was found, which could not be explained by observation in manipulating, the salt was discarded as unfit for the object in view.

The second idea in the experiment was to determine if the actual theoretical amount of nitrogen could be recovered with the various digestion periods employed and if this could not be accomplished, the salt was likewise discarded.

The third idea in the selection of salts was to try to select one or two which were not subject to rapid change through absorption or loss of moisture when exposed to the air for the period of time necessary for weighing. Also if a salt did not pass through the charring stage or if it was not at least partly organic or did not seem to act as the average flour sample does, the salt was again rejected.

The Southern Cottonseed Oil Association has adopted for their standard the use of ammonium sulphate. This salt has been tried and on the thoroughly dried out and desiccated sample which was handled very carefully with regard to protection from moisture it was found to give the maximum amount of theoretical nitrogen under the conditions specified. This salt is quite easily prepared in a very pure state but for this work has had two drawbacks. In the first place ammonium sulphate must be thoroughly dried and desiccated and then must be protected in an extremely careful manner from moisture in the air. The precautions necessary to keep this salt free from moisture are decidedly unhandy.

The second cause of rejection was the fact that this sample does not char in the digestion and does not give a comparable action with cereals in the actual kjeldahl determinations. There is no question but what this salt would be acceptable except for these two features.

Work was done upon a number of salts to determine constant ratio of nitrogen by various methods of handling, especially in digestion, before any attempt was made to select salts for their purity. All of this preliminary work tended to point to the fact that benzamide and ortho benzoic sulphamide (saccharin) would admirably make all the conditions proposed. Samples of these two salts of the very highest purity were secured. These particular samples were secured from the Eastman Kodak Company but others might be equally good. In testing these samples under the various periods of digestion it was soon found that benzamide tended to give an increase in nitrogen up to a maximum at 1½ hours and then a fairly constant decrease in nitrogen at longer periods of digestion. Repeated checks on this seem to verify this statement so we are able to assume that with extremely longer periods of digestion this salt would be unsuitable.

Saccharin was found to give the maximum amount of nitrogen at any period of digestion between half an hour and three hours, tending to indicate that the nitrogen was so firmly bound that it was not lost un-

der conditions of long or hard digestion. The complete results for experiments are not reported but with the exception of alpha naphthylamine sufficient data are reported to show the tendency of the salt under varying digestion periods.

KJELDAHL EXPERIMENTS

List of Organic Salts Used In this Work.

(*1*) *Alpha-naphthylamine*—Formula—$C_{10}H_7NH_2$.
Molar Weight—143.16. Per cent nitrogen—9.784%.
Use ¼ gram—250 mg. Per cent nitrogen—2.446% (as 1 gram.)

(*2*) *Nitroso-beta-naphthol*—Formula—$NO.C_{10}H_6OH$.
Molar weight—173.15—Per cent nitrogen—8.090%.
Use ¼ gram—250 mg.—Per ent nitrogen—2.022% (as 1 gram.)

(*3*) *Strychnine Sulphate*—Formula—$(C_{21}H_{22}N_2O_2)_2.H_2SO_4.5H_2O$.
Molar weight—856.77—Per cent nitrogen—6.539%.
Use ¼ gram—250 mg.—Per cent nitrogen—1.635% (as 1 gram.)

(*4*) *Quinine Sulphate*—Formula—$(C_{20}H_{24}N_2O_2)_2.H_2SO_4.7H_2O$.
Molar Weight—872.804—Per cent nitrogen—6.419%.
Use ¼ gram—250 mg.—Per cent nitrogen—1.605% (as 1 gram.)

(*5*) *Acetanlid*—Formula—$CH_3CONH .C_6H_5$.
Molar weight—135.12—Per cent nitrogen—10.367%.
Use ¼ gram—250 mg.—Per cent nitrogen—2.592% (as 1 gram.)

(*6*) *Ammonimum Sulphate*—Formula—$(NH_4)_2SO_4$.
Molar weight—132.14—Per cent nitrogen—21.201%.
Use 130 mg.—Per cent nitrogen—3.178% (as 130 mg.)

(*7*) *Benzamide—EKCO.*—Formula—$C_6H_5CONH_2$.
Molar weight—121.14—Per cent nitrogen—11.555%.
Use ¼ gram—250 mg.—Per cent nitrogen—2.888% (as 1 gram.)

(*8*)--Ortho-benzoic Sulphamide.
Sacharin EKCO—Formula—$C_6H_4 .CO.SO_2.NH$.
Molar weight—183.17—Per cent nitrogen—7.647%.
Use ¼ gram—250 mg.—Per cent nitrogen—1.912% (as 1 gram.)

It must be noted that when the stated amount is used the percentage of nitrogen has been calculated on the determination as if one gram had been used and all results as reported should be multiplied by four (4), except in the case of ammonium sulphate to get the correct amount of nitrogen contained in the salt. The idea was to express in terms of the usual nitrogen titration chart where usually one gram of material is used for the determination of nitrogen or protein. This simplifies the calculation to determine whether the process as applied is sufficiently accurate. By using the amount indicated, running the kjeldahl determination in the usual way, as well as the titration, one can then read directly from the titration to the percentage of nitrogen found and by comparing this with the calculated percentage for this amount of substance determine at once how much in error the determination has been.

TABLES

Date	Salt No.	Amt. Used	Acid C. C.	Titr.	Blank Corr. C. C.	Nitrogen Per. cent	H2O Corr.	Corr. Result	Time Digest.	Theoretical Nitrogen
1922										
10-10	1	250 Mgm.	25	8.1	0.4	2.310	None	2.310	120	2.446
10-10	2	250 Mgm.	25	12.9	0.4	1.640	None	1.640	60	2.022
10-10	2	250 Mgm.	25	10.8	0.4	1.930	None	1.930	120	2.022
10-11	3	250 Mgm.	25	9.8	0.6	1.380	None	1.380	120	1.635
10-11	3	250 Mgm.	25	15.3	0.6	1.190	None	1.190	60	1.635
10-11	4	250 Mgm.	25	5.2	0.6	1.540	None	1.540	120	1.605
10-25	5	250 Mgm.	25	7.1	0.3	2.464	None	2.464	60	2.592
10-25	5	250 Mgm.	25	6.9	0.3	2.492	None	2.492	90	2.592
10-25	5	250 Mgm.	25	6.7	0.3	2.520	None	2.520	120	2.592
10-28	5	250 Mgm.	25	6.9	0.3	2.492	None	2.492	90	2.592
10-28	8	250 Mgm.	25	13.4	0.3	1.582	None	1.582	90	1.912
10-29	8	250 Mgm.	25	13.4	0.3	1.582	None	1.582	120	1.912
10-30	8	250 Mgm.	25	13.4	0.3	1.582	None	1.582	60	1.912
10-30	8	250 Mgm.	25	13.35	0.3	1.589	None	1.589	120	1.912
10-30	8	250 Mgm.	25	13.35	0.3	1.589	None	1.589	90	1.912
10-31	6	130 Mgm.	25	2.3	0.3	3.136	None	3.136	60	3.178
10-31	6	130 Mgm.	25	2.3	0.3	3.136	None	3.136	120	3.178
11-8	6	130 Mgm.	25	2.7	0.3	3.080	0.095%	3.175	60	3.178
11-8	6	130 Mgm.	25	2.7	0.3	3.080	0.095%	3.175	90	3.178
11-8	6	130 Mgm.	25	2.7	0.3	3.080	0.095%	3.175	120	3.178
1923										
4-5	7	250 Mgm.	25	4.9	0.0	2.814	None	2.814	55	2.888
4-5	7	250 Mgm.	25	4.8	0.0	2.828	None	2.828	70	2.888
4-5	7	250 Mgm.	25	4.7	0.0	2.842	None	2.842	95	2.888
4-5	8	250 Mgm.	25	11.4	0.0	1.904	None	1.904	55	1.912
4-5	8	250 Mgm.	25	11.4	0.0	1.904	None	1.904	65	1.912
4-5	8	250 Mgm.	25	11.4	0.0	1.904	None	1.904	85	1.912
4-6	7	250 Mgm.	25	5.0	0.0	2.800	None	2.800	60	2.888
4-6	7	250 Mgm.	25	4.7	0.0	2.842	None	2.842	90	2.888
4-6	7	250 Mgm.	25	4.5	0.0	2.870	None	2.870	90	2.888
4-6	7	250 Mgm.	25	4.6	0.0	2.856	None	2.856	105	2.888
4-6	7	250 Mgm.	25	4.8	0.0	2.828	None	2.828	120	2.888
4-6	7	250 Mgm.	25	5.1	0.0	2.786	None	2.786	135	2.888
4-11	8	250 Mgm.	25	11-2	0.15	1.911	None	1.911	30	1,912
4-11	8	250 Mgm.	25	11.2	0.15	1.911	None	1.911	60	1.912
4-11	8	250 Mgm.	25	11.2	0.15	1.911	None	1.911	90	1.912
4-11	8	250 Mgm.	25	11.2	0.15	1.911	None	1.911	120	1.912
4-11	8	250 Mgm.	25	11.2	0.15	1.911	None	1.911	135	1.912
4-11	8	250 Mgm.	25	11.2	0.15	1.911	None	1.911	180	1.912

* This sample of salt was not E. K. Co. and was known to be impure.

** Correction for moisture not made.